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A monthly publication of the Geological Survey
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The Secretary of the Interior has deterimined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1991.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

CONTENTS

SUBJECT FIELDS AND GROUPS

Please use the edge index on the back cover to locate Subject Fields and Indexes.

01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

09 MANPOWER, GRANTS, AND FACILITIES

Includes the following Groups: Education—Extramural; Education—In-House; Research Facilities; Grants, Contracts, and Research Act Allotments.

10 SCIENTIFIC AND TECHNICAL INFORMATION

Includes the following Groups: Acquisition and Processing; Reference and Retrieval; Secondary Publication and Distribution; Specialized Information Center Services; Translations; Preparation of Reviews.

SUBJECT INDEX

AUTHOR INDEX

ORGANIZATIONAL INDEX

ACCESSION NUMBER INDEX

SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

RUNOFF PREDICTION UNCERTAINTY FOR UNGAUGED AGRICULTURAL WATERSHEDS.
Hydrologic Engineering Center, Davis, CA.
For primary bibliographic entry see Field 2E.
W91-05130

ABSTRACTS OF THE SECOND INTERNATIONAL SYMPOSIUM ON GAS TRANSFER AT WATER SURFACES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper EL-90-13, August 1990. Final Report. 238p.

Descriptors: *Air-water interfaces, *Symposium, *Gases, *Vapor transport, *Water chemistry, *Proceedings, Model studies, Field tests, Data acquisition, Hydraulic structures, Streams, Rivers, Lakes, Reservoirs.

The second International Symposium on Gas Transfer at Water Surfaces was held 11-14 September 1990 in Minneapolis, MN. The symposium focused on: (1) improvements in the ability to describe the physical and chemical processes associated with gas transfer; and (2) applications of process knowledge to solve engineering problems. Eighty-eight papers were selected for presentation at the symposium in the following topic areas: (1) fundamentals of physical phenomena; (2) modeling; (3) laboratory and field measurement techniques; and (4) applications to streams and rivers, lakes, and reservoirs, hydraulic structures, unit processes, water and wastewater treatment, biogeochemical cycles, seas and oceans, and artificial aeration. The volume contains the abstracts of those papers selected for presentation. The full papers, which are subject to peer review and acceptance, will be published by the American Society of Civil Engineers. (Author's abstract)
W91-05273

NUMERICAL SIMULATION OF THE SURFACE WATER BUDGET DURING HAPEX-MOBILHY.
Centre National de Recherches Meteorologiques, Toulouse (France).
For primary bibliographic entry see Field 2D.
W91-05357

TROPICAL HYDROLOGY AND CARIBBEAN WATER RESOURCES.
Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). 570p. Edited by J. Hari Krishna, Vicente Quinones-Aponte, Fernando Gomez-Gomez, and Gregory L. Morris.

Descriptors: *Caribbean Sea, *Conferences, *Hydrologic systems, *Tropical hydrology, *Tropical regions, *Water resources development, Erosion, Groundwater budget, Groundwater quality, Hydrologic budget, Hydrology, Model studies, Rainfall-runoff relationships, Surface water, Tropic zone, Water quality, Water resources management.

The tropics give rise to the world's largest and longest rivers, and span a diversity of climates ranging from the snow-capped Andean peaks to the coastal mangrove forests. Insular areas in the tropics include some of the highest population densities in the world. The difficulties facing decision makers, researchers, and environmentalists within the tropics and in particular within insular areas are many. To promote the general well being of these areas, a symposium was organized to bring together an interdisciplinary group of scientists and managers devoted to the water resources sciences, to: (1) promote technology transfer between the various disciplines; (2) provide a forum for professionals to exchange experiences, ideas, and potential development of new research studies; (3) provide a source for communication with those who are not water scientists; and (4) provide a forum for the discussion of common water resources management problems. Authors presented studies from about 19 different countries. Fifty-six papers were accepted for publication in these Proceedings and are arranged in four major sections: (1) Water Resources Management, (2) Surface Water Hydrology, (3) Ground Water Hydrology, and (4) Water Quality. Papers within all four sections range from conceptual descriptive papers to very complex research experiments. The range of subjects includes: water management problems, strategies, and new techniques for the management of water resources; rainfall/runoff modeling in tropical environments; extreme flow forecasting; reservoir operation; erosion, sedimentation, and landslide problems; groundwater problems on small tropical islands; geophysical techniques for the study of freshwater lenses; application of numerical techniques to groundwater problems; computer developments for the handling of groundwater data; baseline water quality data and stable isotopic studies; effects of land development on water quality; tracer techniques, drinking and wastewater treatment; and bacteriological water quality studies. (See W91-05612 thru W91-05667) (Lantz-PTT)
W91-05611

INTERNATIONAL PROGRAMME FOR ENVIRONMENTALLY SOUND HYDROLOGIC AND WATER MANAGEMENT STRATEGIES IN THE HUMID TROPICS.
United Nations Educational, Scientific and Cultural Organization, Paris (France). International Hydrological Programme.
For primary bibliographic entry see Field 6A.
W91-05612

STUDY AND APPLICATION OF RAINFALL-RUNOFF MODEL FOR KARST REGIONS.
Nanjing Hydrological Research Inst. (China).
J. Zhang, and Y. Zhuang.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 111-120, 9 fig, 2 tab, 5 ref.

Descriptors: *Flow velocity, *Groundwater movement, *Karst hydrology, *Model studies, *Model testing, *Rainfall-runoff relationships, *Tropical hydrology, Geohydrology, Hydrologic models, Mathematical analysis, Mathematical models, Mathematical studies, Runoff.

A rainfall-runoff model for karst regions is presented. It is a deterministic conceptual model with disperse parameters. In this model, the complexity of a karst region, the simultaneous horizontal and vertical movements through karst, and the differences among flow velocity components of groundwater are considered. The model was applied to 2 karst watersheds and obtained satisfactory results. It can be used in karst regions in which the underground drainage system is well developed and the requirement of water balance is met. This method is a very useful approach to the study of water resources in karst regions. (See also W91-05611) (Lantz-PTT)
W91-05623

RAINFALL-SOIL MOISTURE RELATIONS IN LANDSLIDE-PRONE AREAS OF A TROPICAL RAIN FOREST, PUERTO RICO.
Geological Survey, San Juan, PR. Water Resources Div.
M. C. Larsen, and A. J. Torres-Sanchez.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 121-129, 12 fig, 2 tab, 32 ref.

Descriptors: *Forest hydrology, *Landslides, *Rain forests, *Rainfall-runoff relationships, *Soil water, *Tropical hydrology, *Tropical regions, Geohydrology, Infiltration, Pore water, Puerto Rico, Rainfall, Runoff, Soil stability, Surface runoff, Surface-groundwater relations.

Soil moisture conditions are not well documented in steep, tropical landslide-prone terrain. In the 11,330 hectare Caribbean National Forest in northwestern Puerto Rico more than 170 landslides that occurred from 1 to approximately 60 years ago have been mapped. Most of these landslides are shallow, with failure depths of 0.5 to 7 meters, and are associated with periods of intense, prolonged rainfall. Annual rainfall in the Caribbean National Forest ranges from 2,500 to more than 4,000 mm. Rainfall intensities of up to 65 mm/hour have been recorded in the area during hurricanes. Detailed studies of the relation between rainfall and soil moisture are underway at two forested sites on slopes in the Caribbean National Forest. Soil at the sites is characterized by a layer of silty/clayey colluvial soil about one meter thick, which is underlain by up to 10 meters of saprolite, and overlies weathered volcaniclastic or quartz-diorite bedrock. Although considerable surface runoff has been observed at the study sites, data show moderate to rapid increases in pore pressure in response to short duration storm events. Pore pressure increases are greatest in the lower sections of the concave slopes apparently due to convergent flow. It is anticipated that these pore-pressure data will provide a means of assessing rainfall characteristics leading to landslide initiation as well as insight to the mechanics of shallow landslides. (See also W91-05611) (Author's abstract)
W91-05624

ANNUAL RUNOFF ESTIMATION FOR CATCHMENTS IN INDIA.
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-05786

HUDSON BASIN PRECIPITATION REGIMES: CROTON, ESOPUS, AND SCHOHARIE WATERSHEDS.
Hudson Valley Climate Service, Mahopac, NY.
For primary bibliographic entry see Field 2B.
W91-05796

CLIMATE CHANGE, HYDROLOGY, AND WATER RESOURCES.
Pacific Inst. for Studies in Development, Environment and Security, Berkeley, CA.
P. H. Gleick.
Reviews of Geophysics RVGPB4, Vol. 27, No. 3, p 329-344, August 1989. 5 fig, 3 tab, 94 ref.

Descriptors: *Air pollution effects, *Climatic changes, *Climatology, *Global warming, *Greenhouse effect, *Rainfall-runoff relationships, *Water resources management, Air temperature, Atmospheric circulation, Carbon dioxide, Hydrologic cycle, Hydrologic models, Paleoclimatology, Precipitation, Regional planning.

Growing atmospheric concentrations of carbon dioxide and other trace gases are leading to climatic changes with important implications for the hydrologic balance and water resources. These 'greenhouse gases' are expected to alter the radiative balance of the atmosphere, causing increases in temperature and changes in many other climatic variables. Recent hydrological research strongly suggests that this so-called 'greenhouse effect' will alter the timing and magnitude of runoff and soil moisture, change lake levels, and affect water quality. General circulation models (GCMs) currently provide the best information on the response of the atmosphere to increasing concentrations of greenhouse gases. Changes in climatological variables estimated by GCMs, such as changes in temperature and precipitation, are considered to be more reliable than GCM-predicted changes in runoff or soil moisture. As a result, there is a trend toward using temperature and precipitation estimates for a doubled-CO2 environment as inputs to more detailed regional models, such as paleoclimate analogs. Regional studies suggest that physically-based

models are able to provide considerable information on the regional hydrologic effects of climatic changes, despite uncertainties about many regional details of the future climate. Such changes raise the possibility of environmental and socioeconomic dislocations, and they have important implications for future water resources planning and management. Among the critical issues are the quality of drinking water, supply for industrial activities, agricultural water use, sewage treatment, navigation, hydroelectricity production, and a wide range of environmental services. (Fish-PTT)
W91-05799

GROUND-WATER DISCHARGE TO LAKES: FOCUSING IN EMBAYMENTS.
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
For primary bibliographic entry see Field 2F.
W91-05823

LIGHT STABLE ISOTOPE SYSTEMATICS OF LARGE-SCALE HYDROLOGIC REGIMES IN CALIFORNIA AND NEVADA.
California Univ., Davis. Dept. of Geology.
N. L. Ingraham, and B. E. Taylor.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 77-90, January 1991. 9 fig, 3 tab, 30 ref. California State Water Resources Research Institute Project 569986-28448-3 and University of California Water Resources Center, Project UCAL-WRC-W-656.

Descriptors: *California, *Climatology, *Hydrologic budget, *Hydrologic cycle, *Meteorology, *Nevada, *Tracers, Atmospheric water, Great Basin, Groundwater movement, Hydrogen isotopes, Isotopes, Meteoric water, Oxygen isotopes, Precipitation, Rainfall, Spatial distribution, Surface water, Water vapor.

West-to-east variations in the oxygen and hydrogen isotope composition of surface waters and shallow groundwaters across northern California and Nevada reflect general isotopic changes in atmospheric water vapor accompanying continued precipitation and recycling of water by evaporation. Surface waters, shallow groundwaters, and precipitation samples were collected along three traverses beginning at the California coast and oriented east-west, roughly parallel to the atmospheric flow path of meteoric water. The hydrogen isotope compositions from short-term precipitation records varied as much as 40 parts per thousand (ppt) at one location and were not representative of the annual isotopic composition in precipitation. The hydrogen isotope ratios of surface waters and shallow groundwaters distinguish segments with isotopic variations that correlate with measured vertical fluxes of meteoric water. One coastal segment appears to closely approximate an open system in which precipitation dominates over evapotranspiration. Most segments are described by rather regular variations in deltaD: 3-45 ppt per 100 km, which represent different degrees of closure of the hydrologic system caused by variable partitioning of the precipitation between runoff and evapotranspiration. All partially closed systems imply terrestrial recycling of water. A simple model estimates this amount to be about 20% across northern and central California. Three segments, representing the Great Basin, show virtually no geographic variation and appear to represent isotopically closed systems. (Author's abstract)
W91-05838

EFFECT OF LUMBRICUS TERRESTRIS L. BURROWS ON HYDROLOGY OF CONTINUOUS NO-TILL CORN FIELDS.
Agricultural Research Service, Coshocton, OH.
For primary bibliographic entry see Field 2G.
W91-05878

UNSATURATED SOLUTE TRANSPORT THROUGH A FOREST SOIL DURING RAIN STORM EVENTS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2G.
W91-05880

2B. Precipitation

GLOBAL WORLD PROPAGATION OF DRYNESS AND WETNESS WAVES (PROPAGATION DES ONDES DE SECHERESSE ET D'HUMIDITE A TRAVERS LE MONDE).
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
N. Kayser, J. Probst, D. Cadet, and Y. Tardy.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 310, No. 6, p 757-762, 1990. 3 fig, 1 tab, 12 ref. (English Summary).

Descriptors: *Climatic data, *Climatology, *Rivers, Data collections, Data interpretation.

Climatic fluctuations are understood as quasi cyclic phenomena. Fluctuations of the climatic parameters global temperature, global continental runoff, and southern oscillation index, are correlated with the Sunspot activity. The discharges of the major world rivers are fluctuating together with these parameters. They reflect interannual variations of regional climates. Data were treated first by filtration, then submitted to spectral analysis using the Hayashi method based on the maximum entropy and also to filtering by the Butterworth method. Three quasi periodicities are distinguished, independently of the geographical position: 2-4 yr for 21 rivers, 4-6 yr for 30 rivers, and 10-20 yr for 21 rivers. In Africa, South America, and Asia, the river discharges exhibit 10-20 yr periodicities. In Europe, 2-4 and 4-6 yr periodicities appear equal to or greater than the 10-20 yr. periodicities. The occurrences of these periodicity ranges are in an intermediate state in North America. For the 10-20 yr quasi-periodicity, the western coast of Canada, Brazil, South Africa, Thailand, and Kamchatka appear in phase. River discharge fluctuations for other regions appear shifted by comparison with the Rhone River which was chosen as the reference. Phase lags can be explained as a result of dryness and wetness wave propagation throughout the world. (Feder-PTT)
W91-04938

OBSERVATIONAL STUDY ON PRECIPITATION CHEMISTRY DATA AS A FUNCTION OF SURFACE WIND DIRECTION.
Vrije Univ., Amsterdam (Netherlands). Dept. of Meteorology.
For primary bibliographic entry see Field 5B.
W91-04973

IMPROVING ESTIMATES OF LOW-FLOW CHARACTERISTICS FOR STREAMFLOW STATIONS AFFECTED BY CLIMATIC CYCLES.
For primary bibliographic entry see Field 2E.
W91-05140

EXPECTATION OF MAXIMUM DAILY RAINFALL FOR THE CENTRAL CLIMATIC REGION IN MISSISSIPPI.
University of Southern Mississippi, Hattiesburg. Dept. of Economics.
E. Nissan.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 116-119, 3 tab, 7 ref.

Descriptors: *Estimating equations, *Excess rainfall, *Flood forecasting, *Mississippi, *Probable maximum precipitation, *Rainfall forecasting, Climatic data, Data interpretation, Distribution patterns, Rainfall-runoff relationships, Standard deviation, Statistical analysis.

The occurrence of precipitation in abnormally high amounts is a major cause of flooding which threatens human life and property, and the state of Mississippi is no exception. Analysis of rainfall data is useful, and at times necessary, for the design of hydraulic structures. A methodology has been developed to analyze rainfall data based on the theory of extremes using the largest value of rainfall amount that occurred in a given month. Therefore, during a particular month there is only one measure which describes such a maximum even though there may be many days of the same record. The suggested statistical tool, a special case of order statistics based on distribution-free theory, was used to study the frequency and magnitude of daily extreme rainfall patterns and amounts for Mississippi using data from selected stations in the North Central and Coastal Climatic regions of Mississippi and covering a 30-year period from 1950 to 1980. The results were summarized in tables, with estimated mean and standard deviation of the normal distribution. An example using the tables for calculating expectation of rare events shows that in the next 30 years, it is highly improbable that a one-day rainfall in the month of January will exceed 15.91 inches. With the exception of the months of February, October, and December, the log-normal provides a better fit to the 30 years' data than the normal. (See also W91-05137) (Fish-PTT)
W91-05150

ANTICIPATED EFFECTS OF CLIMATE CHANGE ON FRESHWATER FISHES AND THEIR HABITAT.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
H. A. Regier, and J. D. Meisner.
Fisheries (Bethesda) FISHDN, Vol. 15, No. 6, p 10-15, November/December 1990. 3 fig, 45 ref. Natural Sciences and Engineering Research Council of Canada Grant No. 0GP0003918.

Descriptors: *Aquatic habitats, *Climatic change, *Environmental effects, *Global warming, *Lake fisheries, *Limnology, *Stream fisheries, Climatology, Drought effects, Fish populations, Species composition, Water quality, Water temperature.

To predict the effects of climate change on freshwater fishery resources, an iterative assessment process which uses water temperature, water quantity, and water quality variables is illustrated. The longer and hotter summers that will accompany global warming will shrink cold-water habitat of headwaters and hypolimnia of lakes while warmwater fish populations will expand with increases in their thermal habitat. Drier summers are expected to lead to decreased net basin supply of water to lakes and thus cause reductions in lake levels. Solute concentrations in lakes would likely change if river discharges and lake volumes change with climate and thus could affect the trophic status of lakes. As more information on climate change becomes available, more linkages (e.g., wind, ice cover) could be monitored. (Brunone-PTT)
W91-05164

ANTICIPATED EFFECTS OF CLIMATE CHANGE ON ESTUARINE AND COASTAL FISHERIES.
Maryland Univ., Cambridge. Horn Point Environmental Labs.
V. S. Kennedy.
Fisheries (Bethesda) FISHDN, Vol. 15, No. 6, p 16-24, November/December 1990. 4 fig, 63 ref.

Descriptors: *Environmental effects, *Marine fisheries, *Estuarine fisheries, *Global warming, Distribution patterns, Aquatic habitats, Climatology, Economic aspects, Fish populations, *Climatic change, *Estuaries, *Coastal waters, Sea level, Marine environment, Temperature effects, Species diversity, Water circulation, Marshes, Policy making.

Although the timing and magnitude of global climate change is in dispute, the possible effects of such change merit consideration to allow for discussion of policy ramifications and mitigative actions. Climate change may result in sea level rise; water temperatures increase; and deviations from present patterns of precipitation, wind and water circulation. Estuaries may experience loss of marsh habitat, intrusion of marine waters and associated

organisms, changes in circulation patterns that affect retention of some indigenous species, and increased hypoxia and storm surges. Estuarine and coastal systems could experience poleward retreat of cold-tolerant species and range expansion of warm-tolerant species. Some fisheries and aquacultural enterprises and communities would benefit from the results of climate change and others would suffer losses, with economic and population dislocations probably inevitable in many parts of the world. Thus, flexibility in policy-making and planning will be vital if global climate is modified as rapidly as is anticipated by some scientists. (Author's abstract)
W91-05165

POTENTIAL EFFECTS OF GLOBAL WARMING ON NATIVE FISHES OF THE SOUTHERN GREAT PLAINS AND SOUTHWEST.
Oklahoma Univ., Kingston. Biological Station.
W. J. Matthews, and E. G. Zimmerman.
Fisheries (Bethesda) FISHDN, Vol. 15, No. 6, p 26-32, November/December 1990. 1 fig, 2 tab, 36 ref.

Descriptors: *Endangered species, *Stream ecology, Climatology, Environmental effects, *Climatic change, *Temperature effects, *Fish populations, *Great Plains, *Global warming, Species diversity, Extinction, Genetics.

Fish in streams of the southern Great Plains and southwestern North America may be particularly vulnerable to extirpation or extinction due to global warming. Streams of this region already have some of the hottest free-flowing water on earth (summer maxima of 38 to 40 C), and even now fish live at times very near their lethal thermal limits. Unlike many terrestrial and marine organisms or fishes of some rivers, fishes in these prairie stream systems cannot migrate northward to cooler temperatures in the event of global warming. If warming of 3 to 4 C occurs, a substantial number of species endemic to this region could face extinction unless they adapt behaviorally or genetically for thermal increases. Existing evidence suggests little likelihood or successful behavioral adjustments. Data on thermal tolerance of local populations provide conflicting evidence: one widespread species of the Great Plains shows no difference in thermal tolerance across its range, whereas another shows adaptation to environmental temperatures at the local level. Because of the evolutionarily brief time period predicted for global warming, it is unlikely that genetic options can arise rapidly enough through mutation to allow species to cope with hotter environments. Species that survive major increases in environmental temperature will likely be ones with adequate existing genetic variation to allow survival and selection of at least some individuals. Overall, the outlook for native fishes of the Great Plains and southwest is bleak, if predicted temperature increases occur. (Author's abstract)
W91-05166

DOES HISTORY HAVE A FUTURE. FORECASTING CLIMATE CHANGE EFFECTS ON FISHERIES BY ANALOGY.
National Center for Atmospheric Research, Boulder, CO. Environmental and Societal Impacts Group.
M. H. Glantz.
Fisheries (Bethesda) FISHDN, Vol. 15, No. 6, p 39-44, November/December 1990. 3 fig, 12 ref.

Descriptors: *Forestry, *Fish management, *Global warming, Aquatic productivity, Economic aspects, Social aspects, Political aspects, *Fisheries, *Climatic change, Marine environment, Temperature effects, Fish populations, Resources management.

Fisheries represent an important aspect of economic, social, political, and cultural life in developed as well as developing societies. The relationship between productivity in the marine environment and climate variability and change has not been adequately addressed. Many instances exist in recent times in which climate-related environmental stress (or analogies to such stress) combined to varying degrees with current fisheries management practices to bring about adverse changes in biological productivity. Changes in sea surface temperature, for example, can cause a reduction in biomass or a shift in the location of fish stocks, creating local, national, and international political, economic, and social problems. Assessing societal responses to recent instances of decline in specific fisheries can serve to identify weaknesses as well as strengths that may exist in society's ability to cope with anomalies in biological productivity in the marine environment. Response to change in important fisheries from around the world, like the collapse of the Peruvian anchoveta fishery (early 1970s) and the Anglo-Icelandic Cod Wars (1955 to 1977), may be directly relevant to attempts to improve understanding of how society might cope with fisheries resources affected by possible regional climate change associated with a global warming. (Author's abstract)
W91-05168

KINETICS AND MECHANISMS OF SULFATE ADSORPTION/DESORPTION ON GOETHITE USING PRESSURE-JUMP RELAXATION.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 2K.
W91-05178

UPDATING THE SMITH-FEDDES MODEL.
Arvin/Calspan Advanced Technology Center, Buffalo, NY.
C. W. Rogers, J. T. Hanley, and E. J. Mack.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A210 253. Price codes: A05 in paper copy, A01 in microfiche. Final Report, June 1985. 85p, 10 fig, 15 tab, 82 ref, 2 append. Naval Environmental Prediction Research Facility Contract No. N00228-84-C-3157.

Descriptors: *Model studies, *Smith-Feddes Model, *Cloud liquid water, *Precipitation, *Atmospheric physics, Computer models, Computers, *Cloud physics, Temperature, Fluid drops.

The cloud microphysics of the Smith-Feddes (S-F) model, which includes a table of cloud maximum condensed moisture by temperature, specification of the relative amount of supercooled water and ice in cloud, and designation of drop-sized distributions in cloud, were examined for overall adequacy, accuracy and representativeness with respect to observations acquired since development of the model. Primarily because the S-F condensed moisture table specified same water content value for cumulus clouds without regard to cloud depth, the model was modified so that it computes condensed moisture via moist adiabatic water content for all noncirriform clounds. For cumuliform clouds, the adiabatic water content is reduced to account for entrainment of environmental air. In the original S-F model, the cloud water between the liquid and ice phases in an individual cloud had been incorrectly developed from frequency of occurrence of water, and water and ice in clouds. However, the probability (i.e., frequency of occurrence) that the cloud was all water can be specified, and the S-F model now provides that information as output. (Lantz-PTT)
W91-05277

IMPACTS OF METEOROLOGICAL VARIATIONS ON ACID RAIN ABATEMENT DECISIONS.
Waterloo Univ. (Ontario). Dept. of Systems Design Engineering.
For primary bibliographic entry see Field 5B.
W91-05321

AIRBORNE TRACE METALS IN SNOW ON THE JAPAN SEA SIDE OF JAPAN.
Kanazawa Univ. (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-05355

MAJOR ELEMENT CHEMISTRY, DELTA-2-H, DELTA-18-O AND 87-SR/86-SR IN A SNOW PROFILE ACROSS CENTRAL SCANDINAVIA.
Stockholm Univ. (Sweden). Dept. of Geology.
For primary bibliographic entry see Field 5B.
W91-05356

HISTORICAL EVIDENCE FOR SOUTHERN OSCILLATION-SOUTHERN AFRICAN RAINFALL RELATIONSHIPS.
University of the Witwatersrand, Johannesburg (South Africa). Climatology Research Group.
J. A. Lindesay, and C. H. Vogel.
International Journal of Climatology IJCLEU, Vol. 10, No. 7, p 679-689, November 1990. 3 fig, 3 tab, 72 ref.

Descriptors: *Southern oscillation, *Africa, *Rainfall, *Meteorological data, Climatic data, Seasonal variation, Surface water records, *Climatology, Literature review, *History, Meteorology, Precipitation, Documentation.

Summer rainfall over the central area of southern Africa is known to be modulated with the phase changes of the Southern Oscillation such that rainfall is above normal during high-phase (cold event) and below normal during low-phase (warm event) summers. This relationship holds for the period 1935-1986; the temporal stability of Southern Oscillation-southern African rainfall associations on longer time-scales has not been tested. A documentary-derived rainfall chronology has been developed for the southern parts of the summer rainfall area for the 100-year period 1820-1920, enabling the extension of the rainfall record backward some 60 years before reliable meteorological records are available for the region. Comparison of the documentary series with both early Southern Oscillation chronologies and earliest southern African rainfall records, suggests that the nature of the relationship between summer rainfall over the subcontinent and the Southern Oscillation has remained essentially unaltered since at least 1820. (Author's abstract)
W91-05369

SPACE-TIME VARIABILITY OF RAINFALL IN APRIL AND OCTOBER-NOVEMBER OVER EAST AFRICA DURING THE PERIOD 1932-1983.
Aix-Marseille-2 Univ., Aix-en-Provence (France). Inst. de Geographie.
G. Beltrando.
International Journal of Climatology IJCLEU, Vol. 10, No. 7, p 691-702, November 1990. 7 fig, 22 ref.

Descriptors: *Climatology, Meteorology, *Seasonal variation, Rainfall, History, *Variability, *Analysis of variance, *East Africa, *Meteorological data, *Climatic data, Spectral analysis, *Rainfall distribution, Rainfall rate, Model studies, Kenya, Tanzania, Uganda, Gaging stations.

The space-time variability over East Africa during the two rainy seasons (April and October-November) was investigated using a network of 56 stations for the period 1972-1983 and 32 stations for the period 1932-1983. Analysis of the data relied on a model of two-model variance with rotation, which determined homogeneous groups of stations having a common time evolution. It was found that during April, three components represent a large part of the variance with their cores near the Zanzibar channel, the Kenyan-Tanzanian highlands and eastern Lake Victoria, and the southern part of the Tanzanian highlands. During the October-November rainy season, rainfall is more homogeneously distributed. The first component takes account of 60 percent of the variance and encompasses a large part of the domain, except southern inland Tanzanian stations and western and northern Ugandan stations. Spectral analysis of the time series associated with the space component reveals peaks around 5-6 years, which appears to be the major periodicity over East Africa. (Author's abstract)
W91-05370

ICE-COVER CLIMATOLOGY FOR LAKE ERIE AND LAKE SUPERIOR FOR THE WINTER SEASONS 1897-1898 TO 1982-1983.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2C.
W91-05371

OCCURRENCE AND CHARACTERISTICS OF LOWER TROPOSPHERIC ICE CRYSTALS IN THE ARCTIC.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2C.
W91-05372

DEVELOPMENT OF AN AUTOMATED SPATIAL SYNOPTIC CLIMATOLOGICAL CLASSIFICATION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
R. E. Davis, and L. S. Kalkstein.
International Journal of Climatology IJCLEU, Vol. 10, No. 8, p 769-794, December 1990. 8 fig, 5 tab, 69 ref.

Descriptors: *Climatology, *Climatic data, *Classification, Computerized maps, Cluster analysis, *Data interpretation, *Weather patterns, Weather data collections, Principal component analysis, Synoptic analysis, Thermal water, Surface flow, Atmospheric circulation, Precipitation mapping, Tracking techniques, Environment, Statistical analysis, Meteorology.

The climatic conditions at any one location are determined entirely by the cumulative effect of the weather systems that have passed through that region. Therefore, a complete representation of climate is determined by the entire ensemble of weather elements interacting over time and space. A spatial synoptic climatological index was developed that characterizes the surface weather regime and is capable of assessing and analyzing the impact of synoptic-scale variations on numerous environmental parameters. Based upon surface weather data for the contiguous U.S. for 1984, daily maps were produced that show those areas under the influence of similar weather conditions. The index was developed by applying principal components analysis to a daily matrix of 141 stations by 24 weather elements (chosen to represent the thermal-moisture and surface flow characteristics). The resulting component scores were grouped using a two-stage clustering technique. This yielded a map showing lobes of air having relatively homogeneous weather characteristics. These lobes (clusters) were spatially coherent and corresponded closely to surface weather map features. To allow for the daily tracking of the clusters and the identification of days or weeks after disappearance, the means of each of the daily clusters were grouped across days. The resulting 90-cluster categorization describes all of the major synoptic situations that occurred in 1984, such as maritime and continental polar air masses, frontal passages, and continental high dominance. These groups demonstrate seasonality, regionality, and high within-category similarity. The resulting maps are useful since they are surface weather maps yet add clarity for environmental interpretation. (Author's abstract)
W91-05373

DETERMINISTIC SIGNALS IN USA PRECIPITATION RECORDS: PART I.
State Univ. of New York at Stony Brook. Inst. for Atmospheric Sciences.
R. G. Currie, and D. P. O'Brien.
International Journal of Climatology IJCLEU, Vol. 10, No. 8, p 795-818, December 1990. 22 fig, 1 tab, 62 ref.

Descriptors: *Climatic data, *Precipitation, *Meteorological data, *Model studies, *Solar energy, Wavelengths, California, Colorado, North Carolina, Kansas, Missouri, Ohio, Oregon, Washington, West Virginia, Illinois, Corn belt, Rain gages, Tidal effects, Air temperature, Atmospheric pressure, *Climatology, *Data analysis, *Climatic change.

There is much European literature on the luni-solar wavetrain term in climate data; however, there is a need to address North American data. Spectra and luni-solar wavetrains were examined in rainfall data from the Corn Belt, the Wheat Belt, the northwest U.S., and two 'problem areas,' California and North Carolina. Evidence for the 18.6-year luni-solar wavetrain signal is found in 220 out of 288 (76%) rain-gage records in the states of California, Colorado, Kansas, Missouri, North Carolina, Ohio, Oregon, Washington, and West Virginia, with a mean period of 18.4 +/-1.5 years. The solar cycle signal was found in 70% of these records, with a period of 10.6 +/-0.5 years. For Colorado and states directly east as far as Illinois, minima in most 19-year luni-solar wavetrains were generally in phase with epochs (dates of maximum tidal forcing) 1898.9 through 1954.7. However, by 1973.3 virtually all records east of Colorado had experienced a 180-degree phase switch and wave maxima were in phase with this epoch. In Oregon and Washington most luni-solar waves recorded maxima in wetness at epoch 1898.9 through 1973.3, and thus have historically been out of phase with the continental interior. California records displayed two 180-degree phase switches in the past 100 years, apparently because California is near the edge of a fairly stable continental interior cell that has historically been dry at epochs; and when the dry cell waxes or wanes in areal extent, frequent 180-degree phase switches are produced in areas adjacent to it. The phenomena described have been found in other regions of the U.S., and in records of air temperature and air pressure worldwide. (Author's abstract)
W91-05374

USA CORN YIELDS, THE EL NINO AND AGRICULTURAL DROUGHT: 1867-1988.
Illinois Univ. at Urbana-Champaign. Dept. of Physics.
P. Handler.
International Journal of Climatology IJCLEU, Vol. 10, No. 8, p 819-828, December 1990. 6 fig, 14 ref.

Descriptors: *Drought effects, *Crop yield, *Corn, *El Nino/Southern Oscillation, *Climatology, Climatic data, Agricultural hydrology, Correlation analysis, Tropical regions, Illinois, Iowa, Indiana, Sea water, Water temperature.

Recently there has been a great deal of discussion in the press and elsewhere relating the phase of the El Nino to the outcome of summer crops in the central U.S. The magnitude of spatial and lagged correlation between the sea-surface temperature anomalies of the eastern tropical Pacific Ocean (El Nino) and corn yield in the U.S. was examined. The record is not homogeneous in that the correlation level varies quite strongly over time. The period between 1910 and 1950 shows completely uncorrelated behavior. In the most recent 40 years the correlation is found to be strongest in the region just south of the Great Lakes in the states of Illinois, Iowa, and Indiana. Correlation maps show the degree of association for the corn yield in those 41 states for which records are available. For the entire record the highest correlations occur with the sea-surface temperature anomalies appearing after the corn is harvested in September to February of the following year. Since corn yields are a proxy for summer agricultural drought in the central part of the U.S., the droughts during the period 1910 to 1950 must have had some other cause. (Author's abstract)
W91-05375

ANNUAL AND SEASONAL PATTERNS OF RAINFALL FLUCTUATIONS IN SUB-SAHARAN WEST AFRICA.
Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Geography.
J. O. Adejuwon, E. E. Balogun, and S. A. Adejuwon.
International Journal of Climatology IJCLEU, Vol. 10, No. 8, p 839-848, December 1990. 3 fig, 3 tab, 17 ref.

Descriptors: *Meteorology, *Rainfall distribution, *West Africa, *Annual precipitation, *Climatology, Climatic data, Semiarid climates, Annual distribution, Agricultural water, Seasonal variation, Spectral analysis, Meteorological data collection, Periodicity, Nigeria.

Rainfall fluctuations and trends in West Africa have been the subject of several recent studies; however, most of these studies consider only the annual rainfall totals. In a region where agriculture is rain-fed and rainfall is seasonal, consideration of variability in the seasonal components of rainfall may be more useful in planning. Monthly rainfall data for 16 stations in Nigeria were collected for the period 1922-1985. From this, the annual, wet-season, onset, peak, and retreat rainfall data were derived and the patterns of rainfall fluctuations were analyzed. The series were first examined for trends and then for periodic fluctuations. Trend analysis revealed that a majority of the series exhibit negative trends, and in some cases the trends were significant. For all the series analyzed, there is the general tendency towards increasing aridity. Spectral analysis indicates prominent periods of between 2-year and 8-year cycles. Other periodicities observed include 16-year, 18-year, and 21-year cycles. (Author's abstract)
W91-05376

ONSET OF THUNDERSTORMS AND PRECIPITATION OVER NORTHERN NIGERIA.
Federal Univ. of Technology, Akure (Nigeria). Dept. of Meteorology.
J. B. Omotosho.
International Journal of Climatology IJCLEU, Vol. 10, No. 8, p 849-860, December 1990. 6 fig, 4 tab, 15 ref.

Descriptors: *Climatology, *Thunderstorms, *Precipitation, *Weather forecasting, *Nigeria, Annual precipitation, Convective precipitation, West Africa, Weather forecasting, Drought, Wind, Rainfall, *Meteorology.

It is well-known that the greatest proportion of the annual rainfall of West African countries is from deep convective systems. At least 70% of the total annual precipitation over the coastal areas of Nigeria comes from these mesoscale phenomena, with the Sahelian region of the country almost completely dependent on these systems. It is obvious that reliable thunderstorm/squall-line onset and occurrence prediction are necessary and sufficient requirements for any rainfall (onset and amount) forecasts for the subregion. An empirical prediction scheme for the start of thunderstorms, and the onset and expected amount of rainfall for any year at Kano, Nigeria, was developed, using eight years' upper air data. The years investigated include two drought years (1973 and 1974) and three years of above-average rainfall (1978, 1980, and 1988). Agriculturally sufficient and reliable rainfall begins five to six weeks after the vertical wind shear below the African Easterly Jet (surface, 700 hPa) and the midtropospheric shear (700-400 hPa) simultaneously satisfy the condition: minus 20 m/s is less than or equal to the vertical wind shear is less than or equal to minus 5 m/s; and 0 m/s is less than or equal to the midtropospheric shear is less than or equal to 10 m/s. The total precipitation for any year is found to be well-correlated with the total moisture anomaly (specific humidity) from the week of the above-critical wind shear to the week of rainfall onset. This makes it possible to estimate the expected rainfall total at the very onset of the rains. (Author's abstract)
W91-05377

SPEED OF TWO MOVING RAINFALL EVENTS IN LUND.
Technion - Israel Inst. of Tech., Haifa.
M. H. Diskin.
Nordic Hydrology NOHYBB, Vol. 21, No. 3, p 153-164, 1990. 1 fig, 5 tab, 7 ref.

Descriptors: *Rainfall area, *Storms, *Sweden, *Meteorological data collection, *Weather patterns, Gaging stations, Tracking, Weather data col-

lections, Hyetographs, Precipitation mapping, Estimating, *Meteorology.

Moving storms are characterized by the fact that the rainfall hyetographs recorded at different stations are displaced along the time axis with respect to one another. The speed and direction of movement of rainfall patterns, assumed constant during any given storm, can be derived from data sets comprised of the coordinates (x,y) of a number of rainfall recording stations and the times of arrival of some prominent feature of the recorded hyetographs. The result depends on the nature of the feature adopted. A measure of the significance of the result can also be derived by computing the reduction in the value of the root mean square deviation of arrival times due to the assumption of a moving storm in contrast to the alternative assumption of random fluctuations about an equal arrival time. A procedure has been developed for estimating the accuracy of the results based on repeated computations of the speed and direction using subsets of data obtained by removing records of one rainfall measuring station. The procedure was demonstrated with data recorded in the city of Lund, Sweden, by a network of 12 stations for two different storms. As expected, the speed and direction of storm movement were different for the various definitions of the recognizable feature used with data for the same storm. There is a tendency for results based on the centroid and those based on the median to be approximately the same, but this conclusion must be checked with data for a larger number of storms. Speeds and directions computed from the arrival times of the centroid have the smallest errors, and arrival times based on the arrival times of the peak have the largest errors. (Fish-PTT)
W91-05380

RAIN-RUNOFF PARAMETERS FOR SIX SMALL GAUGED URBAN CATCHMENTS.
Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering.
M. Jensen.
Nordic Hydrology NOHYBB, Vol. 21, No. 3, p 165-184, 1990. 8 fig, 6 tab, 13 ref.

Descriptors: *Rainfall-runoff relationships, *Urban runoff, *Urban watersheds, *Denmark, *Model studies, Rain gages, Regression analysis, Hydrologic budget, Hydrologic data collections, Hydrologic models, Impervious soils, Soil water, Runoff volume, Rainfall intensity, Runoff coefficient, Flood peak, *Small watersheds, *Urban hydrology.

Since 1974 several research projects within urban drainage have been carried out in Denmark to determine parameters for urban catchments necessary for the transformation of rainfall to runoff. Six small study catchments were selected and equipped with automatic rain-runoff gages. The recording period examined covers mostly 1979-1983. Relations between rain-depths and runoff depths were developed using the traditional linear regression model as well as a new continuous model. Both models compute runoff from impervious surfaces in the same way. Calculation of runoff from semipervious surfaces accounts for infiltration through cracks, percolation from a sublayer, and evaporation during dry weather. These phenomena are related to water content of the sublayer. The 10 parameters in the continuous model were calibrated and showed values in good agreement with data from the literature. The continuous model fits the measured runoff depths somewhat better for the largest runoff events. For more frequent events, however, the two models are equally good. Rain intensity-duration-frequency curves were computed. Variations of up to 20%, for return periods 1/5 and 1/2 yr., were seen for catchments with distances approximately 5 km from each other. Peak flow characteristics were compared with rain intensity. The peak runoff coefficient was mostly constant or slightly increasing with the return period. (Author's abstract)
W91-05381

EFFECT OF CLIMATE VARIABILITY AND CHANGE IN GROUNDWATER IN EUROPE.
Aarhus County Dept. of the Environment, Hoejbjerg (Denmark).
R. Thomsen.
Nordic Hydrology NOHYBB, Vol. 21, No. 3, p 185-194, 1990. 6 fig, 11 ref.

Descriptors: *Global warming, *Climatic change, *Climatology, *Europe, *Groundwater recharge, Climatic data, Natural recharge, Paleohydrology, Water supply, Hydrologic models, Available water, Groundwater depletion, Denmark.

Public water supply in Europe relies very heavily on groundwater. Recharge of groundwater takes place mainly in the winter months. An analysis of winter rainfall data from Denmark shows that current recharge rates are abnormally high, and that during several periods in the past the rate has been less than half the current value. In many regions in Denmark present groundwater abstraction is already very close to the limit of the resources. A return to the low values of the past could have catastrophic consequences, but even modest drops would be serious. Useful predictions must be based on climatic models and the full use of climatic, paleohydrological, and historical data. (Author's abstract)
W91-05382

INCREASE OF EARLY RAINS IN SOUTHERN ISRAEL FOLLOWING LAND-USE CHANGE.
Tel-Aviv Univ. (Israel).
J. Otterman, A. Manes, S. Rubin, P. Alpert, and D. O. Starr.
Boundary Layer Meteorology BLMEBR, Vol. 53, No. 4, p 333-351, December 1990. 4 fig, 2 tab, 46 ref.

Descriptors: *Agricultural practices, *Climatology, *Israel, *Land use, *Meteorology, *Precipitation intensity, *Reforestation, *Vegetation effects, Albedo, Heat transfer, Satellite technology, Weather data collections, Weather patterns.

The October rains (at the onset of the rainy season that extends to April) in southern Israel have steeply increased in the last quarter century relative to the prior two decades. A less pronounced, but appreciable, increase is noted for the rest of the rainy season. This apparent reversal of desertification is attributed here to land use changes. Afforestation, increased cultivation, and limitations on grazing after the establishment of the State of Israel resulted in an increased vegetation cover over the inherently high-albedo soils in this region (an area of approximately 10,000 sq km). The changes are apparent in a July 1985 Landsat image of the area. The increase in precipitation is specifically attributed to intensification of the dynamical processes of convection and advection resulting from plant-induced enhancement of the daytime sensible heat flux from the generally dry surface. This enhancement results both from the reduced surface albedo and the reduced soil heat flux (reduced day-to-night heat storage in the soil) in October when insolation is strong. Stronger daytime convection can lead to penetration of the inversions capping the planetary boundary layer (which are weaker in October than in summer) while strengthened advection (sea breeze) can provide moist air from the warm Mediterranean Sea. This suggested mechanism is consistent with previous studies showing that the autumn rains in southern Israel exhibit convective mesoscale characteristics and occur predominantly in the daytime. However, other causes, such as a shift in the synoptic-scale circulation, cannot be ruled out at this stage. (Author's abstract)
W91-05409

MECHANISMS OF INTERANNUAL VARIABILITY OF THE SOUTHWEST UNITED STATES SUMMER RAINFALL MAXIMUM.
Indiana Univ. at Bloomington. Dept. of Geography.
A. M. Carleton, and D. A. Carpenter.
Journal of Climate JLCLEL, Vol. 3, No. 9, p 999-1015, September 1990. 10 fig, 5 tab, 81 ref.

Descriptors: *Arizona, *Climatology, *Probable maximum precipitation, *Rainfall, *Seasonal variation, *Synoptic analysis, Arid lands, El Nino/Southern Oscillation, Precipitation mapping, Rainfall intensity, Semiarid lands, Weather patterns.

The mid-summer rainfall of the Southwest United States (principally Arizona) exhibits marked variations on interannual and decadal time scales. Synoptic mechanisms involved in these variations were examined in associations between the rainfall, the dominant latitude of the summertime mid-tropospheric subtropical ridge (STR) over the Southwest, and the sea surface temperatures (SSTs) of the equatorial and North Pacific region. Sets of extreme years were chosen on the basis of the rainfall and circulation anomalies. Northward (southward) displaced seasonal STR was associated with wetter (drier) summers in Arizona. These extremes tend to follow winters characterized by positive (negative) phases of the Pacific-North America (PNA) teleconnection pattern. This association arises in part from the memory imparted to the atmosphere by the accompanying anomalies of Pacific SSTs. However, during the summer season, more localized anomalies of SST appear important for Arizona rainfall variations. In wet (but not dry) summers, an enhanced longitudinal gradient of SST exists between the west coast of the United States, Baja California, and the Gulf of California. This is accompanied by a steeper gradient of lower tropospheric heights (and implied stronger geostrophic flow) and a reversal in both the total and partial thickness gradients across the region compared with dry summers. These results seem to confirm the importance of lower-level southwesterly flow for moisture transport into the deserts. Recent decadal variations involve particularly runs of wetter (drier) summers in the 1950s (1970s). These variations for years that were non-El Nino/Southern Oscillations may result from the operation of mechanisms similar to those attending the interannual variability of Arizona summer rainfall (namely the STR and Pacific SSTs). A contributory mechanism in the longer-term trend of STR between these decades appears to be a change in the tropical-extratropical gradient of Pacific SSTs during the summer and antecedent spring. The gradient is strengthened during the period, helping to explain the shift to more frequent southward displacements of STR over the Southwest and, accordingly, reduced summer rainfall in Arizona. (Author's abstract)
W91-05412

BIAS AND VARIANCE OF QUANTILE ESTIMATES FROM A PARTIAL DURATION SERIES.
Royal Netherlands Meteorological Inst., De Bilt.
For primary bibliographic entry see Field 7C.
W91-05429

ANNUAL AND SEASONAL FLUCTUATIONS OF PRECIPITATION AND STREAMFLOW IN THE ACONCAGUA RIVER BASIN, CHILE.
Florida Univ., Gainesville. Dept. of Geography.
P. R. Waylen, and C. N. Caviedes.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 79-102, December 1990. 13 fig, 4 tab, 26 ref. NSF Grant SES 8713738.

Descriptors: *Aconcagua River Basin, *Climatology, *El Nino/Southern Oscillation, *Precipitation, *Seasonal variation, *Streamflow, Annual precipitation, Annual streamflow, Chile, Drought, Floods, Meteorology, Snowmelt, Tropical regions.

The El Nino-Southern Oscillation (ENSO) phenomenon has been shown to influence dramatically precipitation and streamflow in tropical western South America. The statistical properties of annual and winter precipitation totals and streamflow characteristics in the Aconcagua River basin, in temperate central Chile, are investigated in such a way as to permit the identification of flood-and drought-generating processes and their possible linkages to upset behavior in the tropical Pacific. Despite the considerable distance to those regions generally associated with ENSO events, the phenomenon produces marked effects upon the various physical processes which govern the surface hydrometeorology of the study area. El Nino years

results in significant increases in annual and winter precipitation, particularly along the coastal margin. The likelihood of rain or rain-on-snow flooding, in the succeeding winter, increases, as does the size of spring snowmelt in the southern summer, 1 year after the upset conditions in the tropical region. Annual low flows are of higher magnitude and occur earlier in the year than is usual. (Author's abstract)
W91-05432

ATMOSPHERIC POLLUTANT DEPOSITION TO HIGH ELEVATION ECOSYSTEMS.
Institute of Ecosystem Studies, Millbrook, NY.
For primary bibliographic entry see Field 5B.
W91-05491

INFLUENCE OF SEA SALT AEROSOLS AND LONG RANGE TRANSPORT ON PRECIPITATION CHEMISTRY AT EL VERDE, PUERTO RICO.
State Univ. of New York Coll. at Oswego. Research Center.
For primary bibliographic entry see Field 5B.
W91-05492

HOLOCENE VEGETATION OF THE HORNADAY MOUNTAINS OF NORTHWESTERN SONORA, MEXICO.
Arizona-Sonora Desert Museum, Tucson.
T. R. Van Devender, T. L. Burgess, R. S. Felger, and R. M. Turner.
Proceedings of the San Diego Society of Natural History, No. 2, p 1-19, September 15, 1990. 4 fig, 5 tab, 40 ref.

Descriptors: *Arid climates, *Climate changes, *Climatology, *History, *Holocene Epoch, *Hornaday Mountains, *Mexico, *Plant growth, *Succession, *Vegetation, Climates, Community composition, Glaciation, Middens, Natural selection, Population density, Rainfall, Seasonal variation, Species composition.

The 94 taxa of plants identified from 10 packrat middens from 240 to 260 m elevation in the granitic Hornaday Mountains provide an excellent history of vegetation and climate for the last 10,000 yr. B.P. in the Pinacate Region of northwestern Sonora, Mexico. Rocky slopes in this arid area (approx. 120 mm/year precipitation) in the Lower Colorado subdivision of the Sonoran Desert have supported desert scrub communities Encelia farinosa (Ef), Larrea divaricata (Ld) and Carnegia gigantea (Cg) throughout the Holocene. Community composition changed continuously on both long (10,000 yrs) and shorter time scales. Ephedra nevadensis, codominant with Ef, Ld, and Cg in early Holocene (8910 to 10,000 years B.P.) samples and rare Juniperus californica imply a continuation of the cool summers and primarily winter rainfall of the late Wisconsin glacial. Middle Holocene samples contained trees and shrubs that are now restricted to relatively mesic washes, implying summer rainfall greater and freezes more frequent than today. Late Holocene samples dominated by Ef and Olneya tesota are similar to present Sonoran Desert vegetation and imply a relatively modern biseasonal rainfall regime with the warmest winters of the Holocene. The modern vegetation of the Hornaday Mountains is as sparse and the climate is as hot and dry as at any time in the last 10,000 years. The variability in community composition throughout the Holocene was similar in magnitude to the modern variability among different midden sites and appears to reflect the highly variable climate. A lowering of sea level of about 100 m during the Wisconsin exposed additional lowlands around the head of the Gulf of California. Responses of individual species to climatic fluctuations on scales from years to millennia may prevent desert scrub communities from ever reaching equilibrium. (Author's abstract)
W91-05597

ARMA MODEL FOR RAINFALL-RUNOFF WITH APPLICATIONS.
Kansas Univ., Lawrence. Dept. of Civil Engineering.
Y. S. Yu, and G. T. Wang.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 81-89, 2 tab, 10 ref.

Descriptors: *ARMA models, *Hydrographs, *Hydrologic models, *Model studies, *Parameter estimation, *Rainfall-runoff relationships, *Tropical hydrology, Data interpretation, Infiltration, Mathematical models, Mathematical studies, Model testing, Runoff.

In practical applications of rainfall/runoff models, the effective rainfall must be determined form the measured rainfall and the estimated hydrologic abstractions such as infiltration, interception, detention, etc.; estimating hydrologic abstractions is the hardest part of this exercise. A rainfall/runoff model which combines an ARMA (autoregressive, moving average) model and Philip's infiltration model is proposed. The model parameters are estimated by using a nonlinear minimization technique based on gradients. With the estimated parameters for a given watershed, the model can be used to compute the runoff hydrograph directly from rainfall hyetograph. Applications of the model to two different watersheds show that the computed runoff hydrographs agree well with actual measurements. The results indicate that the proposed model is apparently a viable alternative to existing models relating effective rainfall to runoff without involving infiltration losses. (See also W91-05611) (Lantz-PTT)
W91-05620

PARAMETER ESTIMATION IN CONCEPTUAL PRECIPITATION-RUNOFF MODELS WITH EMPHASIS ON ERROR ANALYSIS.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
J. Rivera-Santos.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 91-100, 3 fig, 5 tab, 7 ref.

Descriptors: *Error analysis, *Hydrologic models, *Mathematical models, *Model studies, *Parameter estimation, *Rainfall-runoff relationships, *Tropical hydrology, Calibrations, Data interpretation, Mathematical analysis, Mathematical studies, Runoff.

Many problems currently exist during the use of the automatic parameter estimation process in conceptual rainfall-runoff models. In order to obtain acceptable results from a hydrologic model, a suitable calibration process has been sought. The methodology suggested emphasizes residual analysis to identify and quantify the errors and their sources. Special attention is given to input errors, model structural errors, and parameter estimate errors. A brief presentation of the different stages of the calibration process is made, specifically on the selection of the optimization algorithm, the error structure, convergence criteria, calibration and verification data, and sensitivity analysis. One important feature of this methodology is the examination of the response surface of the model's parameters in two and three dimensional plots. Using this technique, initial and final parameters can be assessed as well as the sources of other related problems such as interdependence between parameters. Application of the methodology is demonstrated using the Precipitation-Runoff Modeling System (PRMS) computer program from the USGS with real data. (See also W91-05611) (Author's abstract)
W91-05621

AUTOMATIC PARAMETERS CALIBRATION TECHNIQUE FOR RAINFALL-RUNOFF MODELLING.
National Cheng Kung Univ., Tainan (Taiwan). Dept. of Hydraulics and Ocean Engineering.
S. K. Hsu.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 101-110, 6 fig, 4 tab, 15 ref.

Descriptors: *Automation, *Calibrations, *Data interpretation, *Linear programming, *Model studies, *Parameter estimation, *Rainfall-runoff relationships, *Tropical hydrology, Computer models, Error analysis, Mathematical models, Simulation analysis, Stanford watershed model.

The linear programming technique uses the minimization of the sum of the absolute error between simulated and historical streamflows as the objective function. Using this method, the physical parameters of the relationship of the rainfall-runoff series in target watersheds can be conveniently analyzed and automatically calibrated. The basic rainfall-runoff model adopted in this paper is a modified Stanford Watershed Model (NCKUSWM-1). Eighteen parameters selected from the NCKUSWM-1 model's 40 parameters, with significant characters, are picked up as the variables of the automatic calibration technique used to proceed the calibration of the automation and optimization parameters. For the sake of manipulating and routing the daily discharge with convenience, a day loop added to this modified model can quickly calculate the influenced coefficient matrices in order to apply them for the further automatic calibration. Hence, it is possible to find the representatives of parameters in the watershed model. The application of these methods makes possible the reasonable parameter sets with the premise of water balance and, through a variety of inspections and comparisons from the simulation results, the proposed model's capabilities can be demonstrated. (See also W91-05611) (Author's abstract)
W91-05622

GEOGRAPHIC DISTRIBUTION OF DROUGHT ON TWO CARIBBEAN ISLANDS: PUERTO RICO AND ST. KITTS.
Morris (Gregory L.) and Associates, San Juan, PR.
For primary bibliographic entry see Field 2E.
W91-05626

ROLE OF TEMPERATURE FOR DROUGHT STUDY.
Ohio Univ., Athens. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-05627

CLIMATIC SENSITIVITY OF CALIFORNIA WATER RESOURCES.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W91-05793

HUDSON BASIN PRECIPITATION REGIMES: CROTON, ESOPUS, AND SCHOHARIE WATERSHEDS.
Hudson Valley Climate Service, Mahopac, NY.
J. S. Thaler.
Northeastern Environmental Science NOESDE, Vol. 8, No. 2, p 106-118, 1989. 12 fig, 5 tab, 10 ref.

Descriptors: *Annual precipitation, *Climatology, *Meteorology, *New York, *Rainfall-runoff relationships, *Urban watersheds, *Watershed management, Drought, Fourier analysis, Rain gages, Water demand.

The increasing demands for palatable drinking water as a result of increasing utilization has made an exact assessment of availability from the major watersheds that supply the New York City metropolitan area necessary. The historic precipitation regimes of three New York State Hudson Valley watershed tributaries that provide the major por-

tion of New York City's water supply were examined by mean of network of rain gages that monitor daily precipitation within each of the Croton, Esopus, and Schoharie catchment basins. It was found that the wettest is the Esopus with a mean annual total of 50.31 inches and a range of extremes from 31.63 to 66.89 inches. The Croton watershed shows a mean annual total of 46.05 inches with annual extremes ranging from 33.10 to 63.76 inches. The driest is the Schoharie with a mean annual total of 44.15 inches with annual extremes ranging from 30.19 to 58.40 inches. Annual and monthly normals plus daily extremes were analyzed for three individual rain gages located within each watershed. Standard deviations from the mean annual and monthly precipitation totals reveal the great variability within each of the tributary basins. Such variability poses long-term environmental risks in rapidly urbanizing townships. Digital Fourier Spectral Analysis shows significant periodicity peaks for annual totals at 48.8, 25-26.4, 17.1-18.4, and 4.5 years. Filtered annual totals show that the drought of the 1960s was the major hydrologic event in the 20th century. (Author's abstract)
W91-05796

MONTE CARLO STUDY OF RAINFALL SAMPLING EFFECT ON A DISTRIBUTED CATCHMENT MODEL.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W91-05842

DECAMETRIC VARIABILITY OF SOUDANO-SAHELIAN RAINFALL FIELDS (VARIABILITE SPATIALE DES PRECIPITATIONS SOUDANO-SAHELIENNES A L'ECHELLE DECAMETRIQUE).
Laboratoire de Geologie Appliquee, Paris (France).
J. P. Carbonnel, P. Hubert, E. Walbadet, A. Mermoud, and T. Bariac.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 311, No. 12, p 1425-1430, December 1990. 3 fig, 10 ref. English summary.

Descriptors: *Climatology, *Estimating equations, *Geostatistics, *Meteorology, *Rain gages, *Rainfall distribution, *Statistical analysis, Annual precipitation, Areal precipitation, Burkina Faso, Data acquisition, Data interpretation, Graphical analysis, Isotope studies, Precipitation, Variability.

To characterize the variability of rainfall fields, geostatistical methods can be used. The variogram, estimated from empirical data, yields a synthetic description of the rainfall field structure. Such variograms systematically show a nugget effect for fields relative to single showers or to daily rainfalls, indicating a discontinuity of the variograms for short distances. In this study, sixteen rain gages regularly distributed on a square of 100-meter sides were observed from July to September 1989, in Gampela (Burkina Faso), a Sudanian agronomic research station with 700 mm/year mean precipitation. A geostatistical analysis of 45 rainfall events (from 0.1 to 70 mm) exhibits a continuous rainfield for each event. The 18-O and deuterium analyses confirm this result. Therefore, a sole rain gage is sufficient to estimate the daily rainfall over 1 ha and the rain gage representative area is at least equal to this surface. (Author's abstract)
W91-05850

RETRIEVAL OF PRECIPITATION PROFILES FROM AIRBORNE RADAR AND PASSIVE RADIOMETER MEASUREMENTS: COMPARISON WITH DUAL-FREQUENCY RADAR MEASUREMENTS.
Wisconsin Univ., Madison. Dept. of Meteorology.
J. A. Weinman, R. Meneghini, and K. Nakamura.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 10, p 981-993, October 1990. 7 fig, 2 tab, 19 ref, append.

Descriptors: *Data acquisition, *Data interpretation, *Mathematical analysis, *Meteorological data collection, *Precipitation rate, *Radar, Error analysis, Least squares method, Mathematical equations, Optimization, Precipitation, Radiometry, Rainfall rate, Remote sensing, Weather data collections.

Precipitation rate profiles derived from a single frequency radar and radiometer were compared with such profiles derived from a dual-frequency radar. Measurements obtained during the 1985-86 CRL/NASA rain measuring experiment from airborne X and Ka-band radars and an X-band passive microwave radiometer were used to derive rainfall rate profiles over the Atlantic Ocean. The rainfall retrieval employs the classical Hitschfeld-Bordan radar equation constrained by a measurement of the path integrated extinction derived from passive radiometry. The path-integrated extinction obtained from the radiometric measurements was compared with that obtained from coincident dual-frequency radar reflection measurements from the ocean surface. The mean rainfall rate derived from the path-integrated extinction agreed within 25% with the mean rainfall rate obtained from the reflected radar signals. An error analysis of the retrieval algorithm showed that errors in the path-integrated extinction significantly affect the retrieved rainfall profiles near the surface. A least squares linear extrapolation of the profile in the lowest kilometer was used to revise the boundary condition in the retrieval. The profiles were solved iteratively until the rainfall rate at the surface was within the range of scatter about the linear profile at higher altitudes. An optimization analysis was applied to the derivation of rainfall rate profiles retrieved from a dual-frequency radar data. The results of the retrieval were compared to those obtained from the radar-radiometer retrievals. The availability of only an X-band radiometer limited the retrieval of rainfall rate profiles to maritime cases. It appears that it will be possible to measure rainfall under most conditions when radiometers operating at several higher frequencies become available on future airborne radar experiments. (Author's abstract)
W91-05852

SNOW/CLOUD DISCRIMINATION WITH MULTISPECTRAL SATELLITE MEASUREMENTS.
Naval Postgraduate School, Monterey, CA. Dept. of Meteorology.
R. C. Allen, P. A. Durkee, and C. H. Wash.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 10, p 994-1004, October 1990. 9 fig, 5 tab, 17 ref.

Descriptors: *Algorithms, *Cloud cover, *Data interpretation, *Meteorological data collection, *Remote sensing, *Satellite technology, *Snow cover, Clouds, Infrared imagery, Landsat images, Radiometry, Reflectance Ice.

One of the most significant problems that has plagued automated cloud classification systems is discrimination between low clouds and snow cover; in the visible and infrared regions of the electromagnetic spectrum that are used most often in satellite analysis, low clouds and snow cover have similar radiometric properties. An algorithm has been developed and evaluated for discriminating between clouds, snow-covered land, and snow-free land in satellite image data. The multispectral technique uses daytime images of NOAA AVHRR channels 1 (0.63 micrometers), 3 (3.7 micrometers), and 4 (11.0 micrometers). Reflectance was derived for channel 3 by using the channel 4 emission temperature to estimate and remove the channel 3 thermal emission. Separation of clouds from snow and land was based primarily on the derived channel 3 reflectance. Observed reflectance in channel 3 was 0.02 to 0.04 for snow, 0.03 to 0.10 for land, 0.02 to 0.27 for ice clouds and 0.08 to 0.36 for liquid clouds. These ranges overlap for thin cirrus and snow, so the routine attempts analysis of cirrus based on differences in transmission between channels 3 and 4. Six cases were analyzed and the total cloud cover was verified against a total of 110 surface observations in the standard categories of clear, scattered, broken, and overcast. One of the cases was examined in detail using the algorithm procedures and results. Analysis of cloud cover from the satellite algorithm matched surface observations at 55% of the stations, and was one category different at 33% of the stations. The algorithm differed from the surface observations by two categories at 9% of the stations and by three categories at 4% of the stations. A major remaining problem is discrimination between ice clouds and snow cover. (Author's abstract)
W91-05853

RETRIEVAL OF WATER VAPOR PROFILES FROM MICROWAVE RADIOMETRIC MEASUREMENTS NEAR 90 AND 183 GHZ.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
J. R. Wang, and L. A. Chang.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 10, p 1005-1013, October 1990. 10 fig, 1 tab, 23 ref.

Descriptors: *Atmospheric water, *Cloud cover, *Meteorological data collection, *Microwaves, *Radiation, *Radiometry, *Remote sensing, *Water vapor, Data acquisition, Data interpretation, Error analysis, Radiosondes, Relative humidity, Statistical analysis.

The profiling of atmospheric water vapor using microwave radiometric measurements near the strong absorption line of 183 GHz frequency has been studied by a number of investigators; however, these studies on water vapor retrieval are limited to clear-sky conditions. In order to incorporate cloud effects, upwelling radiometric measurements at 90 GHz and three side bands near 183 GHz were used to retrieve water vapor profiles over the ocean surface. An algorithm incorporating a new technique of handling moderate cloud cover was illustrated for the profiling of both relative humidity and water vapor burden. It was shown that the retrieved relative humidity profiles reflect gross features of the corresponding profiles recorded by the radiosondes. However, the retrieval generally could not produce fine details of the observed profiles at altitudes where a rapid change in relative humidity occurred. For this reason, comparison of retrieved and observed values at a given altitude often yielded an appreciable root mean square (RMS) error. Profiling of water vapor burden, a parameter equivalent to total integrated water vapor above a certain altitude, resulted in much better agreement, as expected. The RMS error obtained from the results of the retrieval at the surface was comparable to that derived from the combination of measurements at 18 GHz and 21 GHz channels of the Scanning Multichannel Microwave Radiometer aboard the Nimbus 7 satellite. (Author's abstract)
W91-05854

ESTIMATION OF AREA-AVERAGED RAINFALL OVER TROPICAL OCEANS FROM MICROWAVE RADIOMETRY: A SINGLE CHANNEL APPROACH.
Texas A and M Univ., College Station. Dept. of Meteorology.
K. S. Shin, P. E. Riba, and G. R. North.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 10, p 1031-1042, 1990. 10 fig, 1 tab, 35 ref.
NASA Grants NAG 5-868 (TRMM) and NAG 5-869 (Climate and Radiation).

Descriptors: *Data interpretation, *Meteorological data collection, *Radiometry, *Rainfall distribution, *Rainfall rate, *Remote sensing, *Tropical regions, Algorithms, Histograms, Marine climates, Microwaves, Model studies, Radiation, Seasonal distribution, Statistical analysis, Statistical models.

A new simple retrieval algorithm has been developed for estimating area-time averaged rain rates over tropical oceans by using single channel microwave measurements from satellites. The algorithm was tested by using the Nimbus-5 Electrically Scanning Microwave Radiometer (ESMR-5) and a simple microwave radiative transfer model to retrieve seasonal 5-degree X 5-degree area averaged rain rate over the tropical Atlantic and Pacific from December 1973 to November 1974. The brightness temperatures were collected and analyzed into histograms for each season and in each

grid box from December 1973 to November 1974. The histograms suggest a normal distribution of background noise plus a skewed rain distribution at the higher brightness temperatures. By using a statistical estimation procedure based upon normally-distributed background noise, the rain distribution was separated from the raw histogram. The radiative transfer model was applied to the rain-only distribution to retrieve area-time averaged rain rates throughout the tropics. An adjustment for the beam filling error was incorporated in the procedure. Despite limitations of single channel information, the retrieved seasonal rain rates agree well in the open ocean with expectations based upon previous estimates of tropical rainfall over the oceans. It is suggested that the beam filling correction factor is the most important, but least understood, parameter in the retrieval process. (Author's abstract)
W91-05855

SIMULATION OF SEASONAL SNOWCOVER BASED ON AIR TEMPERATURE AND PRECIPITATION.
National Inst. of Polar Research, Tokyo (Japan).
For primary bibliographic entry see Field 2C.
W91-05857

CLIMATOLOGICALLY TUNED REFLECTIVITY-RAIN RELATIONS AND LINKS TO AREA-TIME INTEGRALS.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
D. Atlas, D. Rosenfeld, and D. B. Wolff.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 11, p 1120-1135, November 1990. 8 fig, 3 tab, 34 ref, append.

Descriptors: *Climatic data, *Climatology, *Data interpretation, *Mathematical analysis, *Probabilistic process, *Rainfall rate, *Reflectance, *Remote sensing, Atmospheric circulation, Model studies, Moisture density, Radar, Statistical analysis.

The need for climatologically-valid relations, such as those between reflectivity and rain rate, is motivated by the need to understand the role of precipitation in controlling general circulation and influencing climatic phenomena. Relations between either the point or beam-averaged effective reflectivity (Z) and surface rain rate (R) were determined by a probability matching method. The cumulative density functions (CDF) of reflectivity and rain rate were matched at pairs of R, Z which give the same percentile contribution. Range-dependent Z-R relations were obtained by stratifying the Z data by range. Truncation of the Z distribution by too large a threshold caused the threshold rain rate retrieved from the radar data to exceed that in the matching gage distribution. Forcing a match between the mean rate measured by the gages and those retrieved by use of a set of trial Z-R equations provided for the adjustment of the final Z-R relation and compensated for the truncation. The radar-retrieved CDFs of rain rate then replicate the CDF of gage-measured rates nicely. The probability matching scheme produced a Z-R relation that agreed with the bias-adjusted relation, accounting for the approximate inverse relation between the effective reflectivity and beamwidth. The method implicitly includes climatological variations of drop size distribution and rain rate with height due to a variety of physical factors. Because of the sensitivity of the Z-R relation to beamwidth and viewing angle, it cannot be transferred either to airborne or spaceborne radars. The climatologically-tuned Z-R may be applied to smaller space-time domains than those for which they were developed as long as the PDF of Z closely approximates that for which the relation was developed. This occurs in tropical regimes and elsewhere when the day-to-day storms resemble the climatically-typical storm. (Author's abstract)
W91-05858

FRACTALS, RAINDROPS AND RESOLUTION DEPENDENCE OF RAIN MEASUREMENTS.
McGill Univ., Montreal (Quebec). Dept. of Physics.
S. Lovejoy, and D. Schertzer.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 11, p 1167-1170, November 1990. 3 fig, 16 ref.

Descriptors: *Data interpretation, *Fluid drops, *Meteorological data collection, *Rain, *Rainfall distribution, Microwaves, Radiation, Rainfall intensity, Reflectance, Scaling, Spatial distribution, Statistical analysis.

Measurements of the probability distribution of rain drop volumes in rain of various intensities plays an important role both in cloud physics as well as in radar measurements of rain. Theories of drop formation require more than just the relative probabilities of drops of different sizes; they also require knowledge of the relevant spatial distributions. Due to the action of cascade processes concentrating energy, water, and other conserved fluxes into smaller and smaller regions of space, rain is highly variable, displaying scaling (multi)fractal structures over significant ranges in scale. Large (128 X 128 cm) pieces of chemically-treated blotting paper were exposed to rain and both the size and position of the drops were determined. Analyses were performed indicating that the spatial distribution is fractal. This implies that drops cluster over all the observed scales, and, hence, that backscattered microwave radiation from weather radar will have a degree of coherent scattering and a systematic dependence on the measurement resolution not accounted for in the standard theory. Inhomogeneity in rain can be simply characterized by the scaling exponents C2 (the codimension of the drop distribution in the horizontal plane) and H (the scaling exponent of the reflectivity factor with respect to the number of drops). It was found that the first direct empirical estimates of C2,H were C2=0.17, H=0.62, corresponding to the argument that C2>0, H does not equal 1/2. Furthermore, the scaling leads to straightforward corrections to the standard theory in which the relationship between radar measurements and the rain process involves a factor equal to the resolution of the sensor raised to a power whose value may be estimated. (Fish-PTT)
W91-05860

DIAGNOSTICS AND PREDICTION OF ANOMALOUS RIVER DISCHARGE IN NORTHERN SOUTH AMERICA.
Wisconsin Univ., Madison. Dept. of Meteorology.
For primary bibliographic entry see Field 2E.
W91-05861

CHEMICAL ANALYSIS OF RAIN SAMPLES COLLECTED OVER THE PACIFIC OCEAN.
National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs.
For primary bibliographic entry see Field 2K.
W91-05862

PRECIPITATION TYPE TRANSITION REGIONS IN WINTER STORMS OVER SOUTHERN ONTARIO.
Atmospheric Environment Service, Downsview (Ontario).
R. E. Stewart, and P. King.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 13, p 22,355-22,368, December 20, 1990. 16 fig, 35 ref.

Descriptors: *Climatology, *Meteorological data, *Meteorology, *Ontario, *Precipitation, *Storms, *Transition zone, Air temperature, Atmospheric circulation, Canada, Climatic data, Radar, Rain, Snow, Thermodynamics.

Two winter storms passed through the Toronto area during November and December 1987. Information from radar, rawinsonde, and surface observations was analyzed in order to determine the kinematic flow fields and thermodynamic environment in the vicinity of the transition at the surface between snow and rain. This region was also linked to heavy precipitation and thunder. Updrafts preferentially occurred over the snow region, and deep near-0 C layers occurred in the transition region. Observations are consistent with a mesoscale circulation initiated by melting snow and possibly with the occurrence of symmetric instability. It is further suggested that large, possibly wet, snowflakes being formed within such deep near-0 C layers would contribute to the radar detection of precipitation bands near the precipitation transition region. (Author's abstract)
W91-05863

PRECIPITATION IN THE SOUTHERN HIGH PLAINS: METEOROLOGIC AND ISOTOPIC FEATURES.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
R. Nativ, and R. Riggio.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 13, p 22,559-22,564, December 20, 1990. 6 fig, 8 ref.

Descriptors: *Groundwater recharge, *High Plains, *Isotope studies, *Meteorology, *New Mexico, *Precipitation, *Texas, Chlorides, Evaporation, Pacific Ocean, Temperature effects.

The meteorologic characteristics and isotopic composition of precipitation events in the Southern High Plains, Texas and New Mexico, were monitored during one full year to estimate the natural recharge potential of the region's major aquifer. Precipitation events during spring and summer derive their moisture from the Gulf of Mexico. Temperature effects account for the isotopically enriched rainwater during this period, offsetting any possible effects from the amount of precipitation. During fall and winter, precipitation events acquire moisture from the eastern Pacific Ocean. Temperature as well as continental and altitude effects produce isotopically depleted precipitation during this period. Precipitation during events throughout the year that lasted for several days became depleted in both chloride concentration and isotopic composition, thus displaying a front effect. (Author's abstract)
W91-05866

GREENHOUSE EFFECT AND COASTAL WETLAND POLICY: HOW AMERICANS COULD ABANDON AN AREA THE SIZE OF MASSACHUSETTS AT MINIMUM COST.
Environmental Protection Agency, Washington, DC.
J. G. Titus.
Environmental Management EMNGDC, Vol. 15, No. 1, p 39-58, January/February 1991, 5 fig, 4 tab, 51 ref.

Descriptors: *Climatology, *Coastal wetlands, *Global warming, *Greenhouse effect, *Policy making, *Sea level, *Wetlands, Future planning, Land development, Land use, Legal aspects, Property rights, Water level fluctuations.

Climatologists generally expect an anthropogenic global warming that could raise sea level 30-150 cm in the next century and more thereafter. One of the impacts would be the loss of coastal wetlands. Although the inundation of adjacent dryland would enable new wetlands to form, much of this land is or soon will be developed. If developed areas are protected, wetlands will be squeezed between an advancing sea and the land being protected, which has already happened in China and the Netherlands, where people have built dikes for centuries. Unlike those countries, the United States has enough land to accommodate the landward migration of wetlands; but governments lack the funds to purchase all the coastal lowlands that might be inundated and the legal authority to prohibit their development. We propose a third approach: allowing property owners to use coastal lowlands today as they choose, but setting up a legal mechanism to ensue that the land is abandoned if and when the sea level rises enough to inundate it. Although compensation may be required, this approach would cost less than 1% as much as purchasing the land, and would be (1) economically efficient by enabling real estate markets to incorporate expectations of future sea level rise; (2) constitutional by compensating property owners; and (3) politically feasible by pleasing people who care about the long term fate of the

coastal environment without disturbing people who either are unconcerned about the distant future or do not believe sea level will rise. It would be irrational to delay policy formation until sea level rise projections are more precise. The cost will be small if we act now but great if we wait until the sea level is rising along most coasts. The US government should develop a strategy in the next three years. (Author's abstract)
W91-05905

2C. Snow, Ice, and Frost

MONITORING RIVER ICE WITH LANDSAT IMAGES.
Cold Regions Research and Engineering Lab., Hanover, NH. Geological Sciences Branch.
L. W. Gatto.
Remote Sensing of the Environment RSEEA7, Vol. 32, No. 1, p 1-16, April 1990. 10 fig, 1 tab, 42 ref.

Descriptors: *Ice, *Landsat images, *Navigable rivers, *Remote sensing, *River ice, *Satellite technology, Analytical techniques, Inland waters, Mapping, Monitoring, Navigable waters, Photogrammetry, River forecasting.

As part of a program to develop a river ice forecasting model, photointerpretation techniques were used to map the areal distributions of four classes of river ice along the navigable reaches of the Allegheny, Monongahela and Ohio Rivers and the Illinois Waterway each winter from 1972 to 1985 from Landsat Multispectral Scanner, Thematic Mapper and Return Beam images. The four classes, 1)ice-free, 2)partial gray ice, 3)complete gray ice and 4)white ice, were usually readily apparent on the images due to differences in gray tones produced by the various ice types and conditions that make up the different classes. Landsat-derived ice observations compared favorably with available ground and aerial observations 64-80% of the time. During mild winters without extensive and long-lasting ice, or along rivers which normally do not have such ice, Landsat images are less useful because of the time gaps between cloud or haze-free images. (Author's abstract)
W91-05031

WATER PERMEABILITY OF FROZEN SOILS UNDER TREE STANDS IN THE FOREST-STEPPE ZONE.
Soyuzgiproleskhoz Research and Design Institute, Moscow, USSR.
For primary bibliographic entry see Field 2G.
W91-05233

EFFECT OF CHANGES IN THE GEOCRYOLOGICAL CONDITIONS IN THE BASIN OF RESERVOIRS ON FUNCTIONING OF NORTHERN HYDROELECTRIC STATIONS.
For primary bibliographic entry see Field 8C.
W91-05300

ICE CONDITIONS IN POOLS OF THE DAM OF THE KOLYMA HYDROELECTRIC STATION DURING INITIAL OPERATION.
T. E. Kozhevnikova, and N. B. Sakharova.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 104-107, 1990. 2 fig, 3 tab.

Descriptors: *Dam effects, *River ice, *USSR, Hydraulic engineering, *Hydroelectric plants, *Ice formation, *Reservoir operation, Ice cover, Ice thickness, Iced lakes, Reservoir construction, Water level fluctuations, Flow discharge, Cold weather construction, Wave propagation, Ice breakup, Reservoir releases.

The Kolyma (U.S.S.R.) hydroelectric station construction under the harsh climatic conditions of the Far North called for a two-phase startup of the first units at a low head. The initial operating period was characterized by a nonuniform regime with long interruptions and forced releases from the reservoir, caused by subquality construction work, creating unusual conditions in the lower pools. Disturbances of the water level and, accordingly, ice regimes occurred at a distance of 300 km from the hydrostation, which affected the continuous functioning of the economically important ice fordings. As a consequence of the nonuniform water releases, the flow of the reservoir during the winter varied widely: the mean winter flow index W/Q was 2.5-3.5 months, during releases the flow increased by 5-15 times; ice cover formation and breakup on the reservoir was similar to the average natural river on a stretch of rapids; and freezing of the lower pool near the hydrostation occurred usually at small discharges (less than 40 cu m/s). The investigations confirmed an earlier forecast of the length of the stretch of influence of the operation of the hydrostation in daily and weekly regulating regimes. Propagation of release waves with a range of the mean daily discharges from 100 to 500 cu m/s occurred to a distance of more than 300 km from the hydrostation. Fluctuations of the levels in the lower pool immediately below the hydrostation were from 1.5 to 3.2 m, and at a distance up to 230 km away were from 0.8 to 3.2 m. During freezeup such fluctuations caused disturbances in the ice cover and buildup of bank ice ledges, which caused difficulties in operating the ice fordings. The experience of operating the Kolyma hydrostation at a low head yielded considerable data for predicting the ice conditions in lower pools of hydrostations operating under harsh climatic conditions with daily and weekly regulation. (Fish-PTT)
W91-05309

STEAM FOGS IN LOWER POOLS OF HYDROELECTRIC STATIONS AND POSSIBILITIES OF THEIR ARTIFICIAL DISPERSION.
V. I. Khorost'yanov, Y. L. Gotlib, and G. A. Tregub.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 117-122, 1990. 2 fig, 11 ref.

Descriptors: *Dam effects, *Fog, *USSR, Hydraulic engineering, *Hydroelectric plants, *Air-water interfaces, Heat transfer, Reservoir operation, Climatic change, Mathematical models, *Ice cover, Crystallization, Thermal properties.

On-site observations of hydrological and meteorological parameters of regions in the U.S.S.R. with harsh climatic conditions show that in the winter extended stretches of open water form downstream of hydrostations. This causes heavy advection-radiation fog (steam fogs), which changes the conditions of heat exchange of the water with air, affects the length of the polynya and climate of the region, causes the possibility of smog occurrence and icing of cables, and creates difficulties in the operation of air and water transport. A reduction of steam fog over the open water surface in the winter would help counteract the negative effect of a hydrostation on the environment. Mathematical modeling methods were developed to (1) calculate the size and configuration of the zone of steam fog over the polynya in relation to the water temperature and meteorological factors and to evaluate the effect of the steaming process on the intensity of heat exchange of water with air; (2) determine how steaming affects the ice and thermal conditions of the lower pool and in what stretches the precipitation of steam fog is most effective; and (3) recommend ecologically clean methods which can be used for this purpose. Synthesis of two models makes it possible to develop a single model consisting of two units for calculating the microclimate and ice conditions. Prospective methods of regulating the conditions of heat exchange over the open water in the winter by artificial crystallization of steam fog by an ecologically clean crystallizing agent (liquid nitrogen, dry ice) were developed to protect the part of a town or city located on the leeward bank of the river. However, the use of cooling agents to act on fogs in lower pools has not yet been carried out and the strategy of action in this case still remains to be developed. Obviously, it will depend on the wind and temperature conditions, and horizontal length of the fog. (Fish-PTT)
W91-05312

EVIDENCE FOR LARGE-SCALE SUBGLACIAL MELTWATER FLOOD EVENTS IN SOUTHERN ONTARIO AND NORTHERN NEW YORK STATE.
Queen's Univ., Kingston (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2E.
W91-05367

ICE-COVER CLIMATOLOGY FOR LAKE ERIE AND LAKE SUPERIOR FOR THE WINTER SEASONS 1897-1898 TO 1982-1983.
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
R. A. Assel.
International Journal of Climatology IJCLEU, Vol. 10, No. 7, p 731-748, November 1990. 6 fig, 5 tab, 33 ref.

Descriptors: *Ice cover, *Climatic data, *Meteorological data, *Lake ice, *Lake Erie, *Lake Superior, Great Lakes, Model studies, Statistical models, Ice formation, History, Ice, Meteorology, *Climatology.

Observations of mid-lake Great Lakes ice cover are sparse prior to the decade of the 1960s. In an effort to provide an historical perspective of mid-lake ice cover back to the turn of the century, daily average ice cover for Lakes Erie and Superior over 86 winters (1897-1898 to 1982-1983) was reconstructed using empirical-statistical ice cover models developed in an earlier study. Long-term average maximal monthly ice cover occurs in February and is 68% for Lake Erie and 40% for Lake Superior. Mid-lake ice formation occurs about 1 month earlier on both lakes during severe winters. Average maximal monthly ice cover during severe and mild winters is 95% and 14% for Lake Erie, 87% and 17% for Lake Superior. Severe winters are associated with lower 700-mbar heights over the eastern U.S. compared with mild ice cover winters. Analysis of total winter ice cover indicates three ice cover regimes: a high ice cover regime from the late 1890s to early 1920s; a low ice cover regime from the early 1920s to late 1950s; and a high ice cover regime from the late 1950s to the early 1980s. Ice cover climatologies developed during the 1960s and 1970s are not representative of ice covers in the low ice-cover regime of the late 1920s to late 1950s. Spectral analysis of the reconstructed total winter ice cover suggests interannual variations in ice cycles that correspond with the 2-3-year interannual variation in atmospheric variables known as the quasi-biennial oscillation. (Author's abstract)
W91-05371

OCCURRENCE AND CHARACTERISTICS OF LOWER TROPOSPHERIC ICE CRYSTALS IN THE ARCTIC.
Pennsylvania State Univ., University Park. Dept. of Meteorology.
J. A. Curry, F. G. Meyer, L. F. Radke, C. A. Brock, and E. E. Ebert.
International Journal of Climatology IJCLEU, Vol. 10, No. 7, p 749-764, November 1990. 6 fig, 2 tab, 60 ref. NSF Grants DPP-8858830, DPP-8820905, DPP-8209548, and DPP-8822354.

Descriptors: *Ice, *Arctic zone, *Climatology, *Cloud physics, *Atmospheric chemistry, Meteorological data collection, Ice formation, Relative humidity, Thermal radiation, Snow, Air temperature, Meteorology, Particle size, Precipitation.

In the Arctic, the presence of small ice crystals in otherwise clear air has been noted in the literature. If the ice crystals extend down to the surface, they are frequently referred to as 'cloudless' ice-crystal precipitation. Because of difficulties in observing these ice crystals, both from the surface and satellite observation, and owing to the ambiguities of cloud classification in the polar regions, these ice crystals are not included in current cloud climatologies. Data was obtained from the University of Washington Convair C-131A research aircraft during April 1983 and 1986, including the frequency of occurrence of ice crystals as a function of height, temperature, and relative humidity. Radiative transfer calculations were made using the

observed ice-crystal size distributions. The radiative transfer through the ice crystal layers is inferred to have a substantial impact on visibility in the Arctic, the vertical temperature structure of the Arctic troposphere, and on the surface energy balance. These layers of ice crystals can have depths exceeding 3 km and extinction optical depths as large as 21. In addition to being important in the Arctic radiation budget, cloudless ice-crystal precipitation is believed to be important in the surface accumulation of snow and also in Arctic air chemistry. (Fish-PTT)
W91-05372

COMPARISON OF ESTIMATES OF SNOW INPUT WITH A SMALL ALPINE CATCHMENT.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
R. A. Sommerfeld, R. C. Musselman, and G. I. Woolridge.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 295-307, December 1990. 4 fig, 3 tab, 12 ref.

Descriptors: *Data interpretation, *Error analysis, *Precipitation mapping, *Runoff forecasting, *Snow accumulation, *Snow surveys, Alpine regions, Comparison studies, Hydrologic data collections, Snow cover, Snow depth, Snowmelt, Vegetation effects, Wyoming.

Five methods were used to estimate the snow water equivalent input to the Glacier Lakes Ecosystem Experiments Site (GLEES) in south-central Wyoming during the winter 1987-1988 and to obtain an estimate of the errors. The methods were: (1) Martinec and Rango degree-day method; (2) Wooldridge et al. method of determining the average yearly snowfall for tree morphology; (3) precipitation gage measurements from the Wyoming Water Research Center Snowy Range Observatory; (4) NADP collector data; and (5) an independent estimate from snow core data from a small catchment in the GLEES. Estimated water input ranged from a low of 65 cm H2O (liquid water equivalent) for the precipitation gage to a high of 85 cm H2O for the Martinec and Rango method. An evaluation of the biases in the methods indicate that the true value may be nearer the high end of this range. The accuracy was estimated at + or -10%, or a range of 77-94 cm H2O. (Author's abstract)
W91-05444

IONIC TRACER MOVEMENT THROUGH A WYOMING SNOWPACK.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 5B.
W91-05490

MODELING SOLUTE TRANSPORT IN GROUND WATER AT OR NEAR FREEZING.
Alaska Univ., Fairbanks. Dept. of Mining and Geological Engineering.
For primary bibliographic entry see Field 5B.
W91-05816

SOLUTE REJECTION IN FREEZING SOILS.
HydroGeoLogic, Inc., Herndon, VA.
For primary bibliographic entry see Field 2K.
W91-05840

SIMULATION OF SEASONAL SNOWCOVER BASED ON AIR TEMPERATURE AND PRECIPITATION.
National Inst. of Polar Research, Tokyo (Japan).
H. Motoyama.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 11, p 1104-1110, November 1990. 10 fig, 2 tab, 9 ref.

Descriptors: *Air temperature, *Japan, *Model studies, *Precipitation, *Simulation analysis, *Snow cover, Compaction, Hokkaido, Honshu, Rain gages, Simulated rainfall, Snow depth, Snowmelt, Snowpack, Viscosity coefficient.

The depth of snow decreases gradually with time after the formation of snow cover due to settling densification of the snow layer, even without melting. A simulation was performed for the time variation in depth of seasonal snow with variable air temperature and precipitation in Japan. Processes of snow densification and snowmelt were considered for snow depth calculation. The parameters tested were a precipitation gage deficiency parameter (b), the solid/liquid precipitation portion of total precipitation at air temperature (T), temperature dependence of the compactive viscosity factor, the snowmelt at surface of snow cover, and snowmelt at the bottom of snow cover. The calculated snow depth was found to be well fitted to the observed snow depth using the same parameters over eight years. The value of b was found to be 0.6-1.0. The T was 0 C at Hokkaido (northern Japan) and 2-3 C at Honshu (central Japan). The melting index for calculating surface snowmelt was larger in Honshu than in Hokkaido. The viscosity factor took a low value when the snow cover warmed or became wet. If air temperature shifts plus-or-minus 2 C, the period of continuous snow cover will be changed by 10-15 days, and the maximum snow depth will change approximately 0.5-1.0 m. (Author's abstract)
W91-05857

CRITIQUE OF THE CLIMATIC RECORD OF 'WATER EQUIVALENT OF SNOW ON THE GROUND' IN THE UNITED STATES.
Kent State Univ., OH. Dept. of Geography.
T. W. Schmidlin.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 11, p 1136-1141, November 1990. 1 fig, 1 tab, 27 ref, append.

Descriptors: *Climatic data, *Meteorological data collection, *Snow cover, *Water equivalent, *Weather data collections, Data quality control, Network design, Snow depth, Snowmelt.

The water equivalent of snow on the ground (SWE) has been measured daily since 1952 at National Weather Service first-order stations whenever snow depth exceeded 5 cm (2 in). These data are used in snowmelt analyses, snow climatology, and snow load design calculations for building codes. Problems with this measurement that may affect data quality include: (1) inconsistent methods of measurement among stations and within many stations' records, (2) unrepresentative and inconsistent locations of measurement, (3) a six-hour lag between daily measurement of snow depth and SWE, and (4) numerous errors in the climatic record of extreme SWE values. These data have not been viewed critically in the literature and are not subjected to rigorous quality control at the National Climatic Data Center. Suggestions for improving the quality of SWE data include: consistent and daily SWE measurement methods, SWE measurement made at 1200 UTC along with the daily snow depth, and use of a quality control procedure to flag anomalous SWE data at national, state, federal, and private-vendor climate centers. (Author's abstract)
W91-05859

2D. Evaporation and Transpiration

VAPOR-BUDGET MEASUREMENT OF IRRIGATION EVAPORATIVE LOSSES.
Clemson Univ., SC. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W91-05135

WATER BALANCE ESTIMATION MODEL: FIELD TEST AND SENSITIVITY ANALYSIS.
Institut des Savanes, Bouake (Ivory Coast).
For primary bibliographic entry see Field 2G.
W91-05183

NUMERICAL SIMULATION OF THE SURFACE WATER BUDGET DURING HAPEX-MOBILHY.
Centre National de Recherches Meteorologiques, Toulouse (France).
J.-F. Mahfouf.
Boundary Layer Meteorology BLMEBR, Vol. 53, No. 3, p 201-222, November 1990. 11 fig, 5 tab, 26 ref. Institut National des Sciences de l'Univers Grant PAM 883614.

Descriptors: *Evaporation, *Hydrologic budget, *Mathematical models, *Simulation analysis, *Data interpretation, *Surface water data, Numerical analysis, Meteorological data collection, Evapotranspiration, Soil water, Soil temperature, Relative humidity, Soil moisture deficiency, Vegetation effects, *Model studies, Soil properties, Rainfall-runoff relationships.

During the last ten years, considerable effort has been devoted to improving the formulation of evaporation over land surfaces in numerical meteorological models. As a result, detailed land surface parameterizations, taking into account soil texture and vegetation coverage in the estimation of surface evapotranspiration, are beginning to appear. With field experiments such as HAPEX-MOBILHY, which provide data sets of surface hydrology processes over regional areas, it becomes possible to validate and improve such parameterization schemes. A simple land surface parameterization scheme previously validated at the daily time scale was studied for monthly periods using the HAPEX-MOBILHY data set. For a set of six locations, the scheme reproduced with good accuracy two components of the surface water budget (evaporation and soil moisture depletion) when the observed rainfall rate at the ground surface was specified. For two sites, measurements of soil moisture content near the surface allowed the behavior of the surface water content to be validated. The results compare favorably with the data, although runoff from the interception reservoir is overestimated for well-developed crops. As runs were interactive with the planetary boundary layer, it has been possible to check the quality of the scheme by examining screen-level parameters (temperature and relative humidity). The model provides a reasonable evolution of the air temperature and relative humidity for most of the sites, except when the local properties of the surface strongly depart from the environmental ones. (Fish-PTT)
W91-05357

EVAPOTRANSPIRATION FROM THE MARGIN AND MOIST PLAYA OF A CLOSED DESERT VALLEY.
Utah State Univ., Logan. Dept. of Soil Science and Biometeorology.
E. Malek, G. E. Bingham, and G. D. McCurdy.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 15-34, December 1990. 9 fig, 5 tab, 31 ref, append.

Descriptors: *Deserts, *Evaporation, *Evapotranspiration, *Microclimatology, *Playas, Air temperature, Albedo, Bowen ratio, Heat transfer, Osmotic pressure, Radiation, Salt flats, Transpiration, Vapor pressure, Water table.

Two long-term microclimate measurement stations with Bowen ratio capability were used to study water cycling in a closed desert basin. Microclimate variables including the temperature and vapor pressure gradients were monitored continuously and used to estimate the Bowen ratio, sensible and latent heat fluxes during 1986 and 1987. Despite having a water table that varied between the surface and 30 cm below the surface, the playa had little evaporation except after rainfall events. The very high osmotic pressure of the soil and salt crust caused most of the rainfall events. The very high osmotic pressure of the soil and salt crust caused most of the absorbed radiation to be partitioned to sensible heat. In contrast, along the margin the thin grass and brush cover transpired water freely, with the latent heat flux exceeding 60% of available energy for much of the season. The higher air temperatures above the playa raised potential evapotranspiration (ET) significantly higher than along the margin throughout the summer. The annual average actual ET of the playa was only 36% of the margin. During the drier summer period (May-October), this ratio de-

creased to <28%. Immediately after a rainfall event, evaporation rates of the two sites were similar, but the playa rate was quickly reduced as the osmotic potential increased. During this study, the playa lost <220 mm of subsurface water to evaporation annually, while >638 mm were lost from the margin groundwater supply. The 24-hr solar and net radiation correlations were 0.80 and 0.94 for the playa and margin, respectively. The lower correlation for the playa resulted from the wide variation of albedo with surface moisture changes. The annual average albedo values for the playa and margin were 0.64 and 0.46, respectively. (Author's abstract)
W91-05428

CHECKS ON THE MEASUREMENT OF POTENTIAL EVAPOTRANSPIRATION USING WATER BALANCE DATA AND INDEPENDENT MEASURES OF GROUNDWATER RECHARGE.
Liverpool Univ. (England). Dept. of Geography.
C. I. Essery, and D. N. Wilcock.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 51-64, December 1990. 10 fig, 27 ref.

Descriptors: *Evaporation, *Evapotranspiration, *Groundwater recharge, *Hydrologic budget, *Measuring instruments, *Transpiration, Lysimeters, Performance evaluation, Rainfall, Soil moisture deficiency, Surface-groundwater relations, Vegetation effects.

A twelve-year record of daily evaporation and evapotranspiration measurements at the Colerain campus of the University of Ulster in Northern Ireland was analyzed to check the accuracy of potential evapotranspiration (PE) measurements. PE was independently derived from: (1) Penman PT estimates derived from daily records of maximum and minimum temperature, wind speed, vapor pressure and sunshine hours; (2) irrigated grass lysimeters, PE(L); and (3) measurements of tank evaporation, PE(T). Both PE(T) and PE(L) were higher in winter than PT and had more prolonged summer peaks. Examination of soil moisture deficits during the period showed that actual evapotranspiration (AE) rarely fell below the potential rate and that PE and AE were therefore equal for most of the year. The availability of rainfall, stream discharge and groundwater data from an instrumented river catchment on the University campus enabled water balances to be constructed for the period of study. Separate water balances using each of the PE estimates showed that Penman PT most satisfactorily reflected catchment storage changes monitored independently. Penman PT was confirmed as the most appropriate estimate of PE for the climatic, soil and vegetation conditions of the region. The use of Penman PT in water balance determinations, however, does not secure perfect agreement between estimated recharge and depletion of catchment storage on the one hand, and observed changes in water-table level on the other. The combined effects of error in surface water balance determinations were estimated at about 13%. (Author's abstract)
W91-05430

EXAMINATION OF MORTON'S CRAE MODEL FOR ESTIMATING DAILY EVAPORATION FROM FIELD-SIZED AREAS.
Saskatchewan Univ., Saskatoon. Div. of Hydrology.
R. J. Granger, and D. M. Gray.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 309-325, December 1990. 13 fig, 14 ref.

Descriptors: *CRAE Model, *Evaporation, *Evapotranspiration, *Hydrologic models, *Model studies, Albedo, Mathematical models, Mathematical studies, Radiation, Wind velocity.

Morton's complementary relationship areal evapotranspiration (CRAE) model was originally designed to provide regional estimates of monthly evapotranspiration, but it has been applied to field-sized land units for a shorter interval of time. CRAE was examined with respect to the algorithms used to describe different terms and its applicability to reduced spatial and temporal scales. Daily estimates by CRAE of atmospheric radiation fluxes during the summer months were compared with monitored values. Errors in estimation of the extra-terrestrial flux, the transmittancy of clouds to short-wave radiation, the surface albedo and the net long-wave flux result in standard deviations of the difference between modeled and measured net all-wave radiation for 1-, 5-, and 10-day periods of 2.58, 1.8 and 1.50 MJ/sq m/day, respectively. The assumption in CRAE that the vapor transfer coefficient is independent of wind speed may lead to appreciable error in computing evapotranspiration. A procedure for incorporating a wind correction factor involves introducing a vapor transfer coefficient based on the aerodynamic equation into CRAE which reduced the mean difference between CRAE and observed monthly estimates of summer evaporation from 0.60 to 0.18 mm/day. Comparisons of evapotranspiration estimates by CRAE and measurements obtained from soil moisture and precipitation observations in the semi-arid, cold-climate Prairie region of western Canada demonstrate that the assumptions that the soil heat flux and storage terms are negligible, lead to large overestimation by the model during periods of soil thaw. (Author's abstract)
W91-05445

EFFECTIVENESS OF EVAPOTRANSPIRATION SYSTEMS IN DISPOSING OF WASTEWATER IN REMOTE ABORIGINAL COMMUNITIES IN NORTHWEST AUSTRALIA.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5E.
W91-05510

HUMIDITY AND SOIL WATER INFLUENCE THE TRANSPIRATION RESPONSE OF MAIZE TO CO2 ENRICHMENT.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
A. G. Barr, K. M. King, G. W. Thurtell, and M. E. D. Graham.
Canadian Journal of Plant Science CPLSAY, Vol. 70, No. 4, p 941-948 October 1990. 2 fig, 2 tab, 22 ref.

Descriptors: *Corn, *Humidity, *Soil water, *Soil-water-plant relationships, *Stomatal transpiration, *Transpiration, Carbon dioxide, Crop yield, Drought, Leaves, Productivity, Soil amendments, Stress.

The impact of increasing atmospheric CO2 on the productivity of C4 crops may vary with soil water availability. Differences in water-stress-induced stomatal closure in maize (Zea mays L.) plants growing at 300 and 600 micro mol/mol CO2 were examined by comparing the response of transpiration and leaf conductance at both CO2 levels to changes in the vapor pressure deficit and soil water content. Transpiration and leaf conductance were measured at 300 and 600 micromol/mol CO2 as the vapor pressure deficit was stepped through five levels per day, and as the soil dried during an 8-day period without watering. The objective was to test the hypothesis that doubling CO2 reduces the degree to which transpiration is limited by soil water at high vapor pressure deficits and low soil water contents. Doubling CO2 caused an overall reduction of 23% in the transpiration rate and 34% in the leaf conductance, but the effect of CO2 on transpiration and leaf conductance was greatest at high soil water content and low vapor pressure deficit, when soil water least limited transpiration. The results indicate that CO2 enrichment reduces the degree of drought-induced stomatal closure in maize plants at low soil volumetric water content or high vapor pressure deficit. It is expected that this reduction will contribute to a positive yield response of C4 crops to elevated CO2 when water is limiting. Presumably, a higher incidence and severity of water-stress-induced stomatal closure at lower CO2 would reflect not only reduced transpiration, but also reduced carbon assimilation. (Agostine-PTT)
W91-05557

ESTIMATION OF TOTAL WATER CONSUMPTION OF SELECTED VEGETABLE CROPS IN THE SEMIARID AND HUMID REGIONS OF PUERTO RICO.
Puerto Rico Univ., Mayaguez.
For primary bibliographic entry see Field 3F.
W91-05632

2E. Streamflow and Runoff

POTENTIAL OF BASING AN ECOLOGICAL TYPOLOGY OF AQUATIC SEDIMENTS ON THE NEMATODE FAUNA: AN EXAMPLE FROM THE RIVER RHINE.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nematology.
For primary bibliographic entry see Field 5A.
W91-04960

PHASES IN THE DEVELOPMENT OF RIVERINE PLANKTON: EXAMPLES FROM THE RIVERS RHINE AND MEUSE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04961

SEDIMENT SEEDBANKS IN GRASSLANDS ON THE MAGELA CREEK FLOODPLAIN, NORTHERN AUSTRALIA.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
For primary bibliographic entry see Field 2H.
W91-04985

COMPARATIVE ASSESSMENT OF LINE TRANSECT AND POINT INTERCEPT METHODS FOR STREAM PERIPHYTON.
North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-04997

INTERACTION BETWEEN THE EFFECTS OF SUBSTRATUM, VELOCITY AND LOCATION ON STREAM BENTHOS: AN EXPERIMENT.
Monash Univ., Clayton (Australia). Dept. of Botany.
L. A. Barmuta.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 5, p 557-573, 1990. 3 fig, 9 tab, 59 ref.

Descriptors: *Benthic environment, *Flow velocity, *Limnology, *Stream biota, *Streamflow, Colonization, Detritus, Habitats, Pebbles, Riffles, Stream morphology.

Patches of large and small pebbles were created in three riffles (fast current velocities) and three pools (slow velocities). It was expected that patches with different sizes of pebbles in the two velocity regimes would vary in the entrapment of fine sediments and organic matter, which in turn would result in differences in benthic community structure. This was not the case. Although deposition of fine material was greater in pools, there were appreciable location specific differences in the fauna unrelated to the variables monitored in the experiment. Functional feeding groups did not respond predictably to the distribution of detritus. Generally, the community was least influenced by substratum size, with any differences being inconsistent across locations. Most other substratum effects were attributable to the presence of epilithon on undisturbed control patches. Velocity was the most influential factor, with riffles having higher total abundances and higher species richness. Some taxa showed strong location specific differences. At the level of a small patch of pebbles, the colonization dynamics of the fauna are probably a mixture of species and location specific dispersal and selection mechanisms. At larger spatial scales community structure is more predictable, with pools differing substantially from riffles. (Author's abstract)
W91-05003

OPTICAL PROPERTIES OF WATERS IN THE MURRAY-DARLING BASIN, SOUTH-EASTERN AUSTRALIA.
Murray-Darling Freshwater Research Centre, Albury (Australia).
R. L. Oliver.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 5, p 581-601, 1990. 7 fig, 4 tab, 38 ref.

Descriptors: *Darling River Basin, *Murray River Basin, *Optical properties, Absorption coefficient, Algae, Australia, Chlorophyll a, Dissolved solids, Irradiance, Light scattering, Phytoplankton, Spectrophotometry, Suspended solids, Turbidity.

Apparent and inherent optical properties were determined for a range of water types in the Murray-Darling basin by using a combination of field and laboratory techniques. The absorption coefficient was calculated directly from in situ irradiance measurements and photosynthetically active radiation, whereas the scattering coefficient was determined from the irradiance measurements in conjunction with published nomograms relating the apparent and inherent optical properties. The validity of the nomograms for use in these waters was confirmed by comparing values of the average cosine calculated directly from in situ measurements with those estimated from nomograms. These were closely correlated except for sites with chlorophyll concentrations greater than 200 mg/cu m. The scattering coefficients estimated from the nomograms were approximately numerically equal to the turbidity in nephelometric turbidity units, but the variability of the relationship made it unsuitable for checking the validity of the nomograms. The relative role of dissolved and particulate components in the absorption and scattering of irradiance was examined by using spectrophotometry and linear regression of inherent optical properties on concentrations of the components. Estimates of specific absorption and scattering coefficients for algae, non-chlorophyllous suspended particles, and dissolved yellow color were comparable to similar coefficients reported in the literature. The relative importance of these components to absorption and scattering varied considerably between sites and demonstrated the need for information on inherent optical properties in understanding the factors causing changes in optical water quality. (Author's abstract)
W91-05004

EFFICIENCY ESTIMATES OF A STREAM BENTHOS SUCTION SAMPLER.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
For primary bibliographic entry see Field 7B.
W91-05006

PATTERN OF PARTICULATE NITROGEN TRANSPORT IN WORLD RIVERS.
Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelschemie.
For primary bibliographic entry see Field 5B.
W91-05018

VEGETATED BUFFER ZONE EXAMINATIONS ON THE VANTAA RIVER BASIN.
Water Protection Association of the Vantaa River and Helsinki District (Finland).
For primary bibliographic entry see Field 4D.
W91-05065

RUNOFF PREDICTION UNCERTAINTY FOR UNGAUGED AGRICULTURAL WATERSHEDS.
Hydrologic Engineering Center, Davis, CA.
D. M. Goldman, M. A. Marino, and A. D. Feldman.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 752-768, November/December 1990. 8 fig, 6 tab, 22 ref.

Descriptors: *Flood flow, *Flood frequency, *Hydrologic models, *Model studies, *Rainfall-runoff relationships, *Runoff, *Runoff forecasting, *Ungaged watersheds, Agricultural runoff, Errors, Infiltration, Mathematical models, Nebraska, Performance evaluation, Prediction, Soil water, Stochastic models.

A common approach to deriving flood-flow-frequency curves for an ungaged watershed is to simulate a design storm with an event-oriented watershed model. Loss rate parameter estimation for an event-oriented model consists of determining both the soil moisture condition prior to the rainfall event and the soil infiltration parameters. A physically based stochastic watershed model was used to estimated runoff prediction uncertainty for small agricultural watersheds in Hastings, Nebraska. The stochastic nature of the model results from postulating a probabilistic model for parameter estimation and input errors. The key factors assumed to control prediction uncertainty are errors in estimating infiltration parameters and moisture conditions prior to a rainfall event. The error distributions for parameter estimates were inferred from soil survey information, and the error distribution for moisture conditions from a regression between antecedent precipitation indices and measured soil moisture. Comparison of model predicted and observed errors demonstrated that the model is conservative in that it is biased towards overprediction of errors. (Author's abstract)
W91-05130

RATING CORRECTION FOR LATERAL SETTLEMENT OF PARSHALL FLUMES.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W91-05133

PROCEEDINGS, TWENTIETH MISSISSIPPI WATER RESOURCES CONFERENCE, 1990.
Mississippi Water Resources Research Inst., Mississippi State.
Available from the National Technical Information Service, Springfield, VA as PB90-274176. Price codes: A09 in paper copy, A02 in microfiche. 10-11 April, 1990. 187 p. Edited by B. Jean Daniel.

Descriptors: *Conferences, *Institutions, *Mississippi, *Water management, *Water quality, *Water resources, *Water supply, Aquifers, Groundwater, Model studies, Reservoir control, Streamflow, Tennessee-Tombigbee Waterway.

The twentieth Mississippi Water Resources Conference was held April 10-11, 1990, in Jackson, Mississippi. The papers, covering institutional issues of water management, water quantity and water quality management basic research, and water supply problems, appear in this Proceedings in the order presented at the conference. The program and a list of conference participants are included. The co-sponsors were: Mississippi Water Resources Research Institute, the Mississippi Bureau of Land and Water Resources, and the Mississippi District Office, U.S. Geological Survey. (See W91-05138 thru W91-05159) (Fish-PTT)
W91-05137

COMPREHENSIVE STUDY OF EAST FORK OF THE TOMBIGBEE: RESOURCE ISSUES BY THE CORPS OF ENGINEERS AND SOIL CONSERVATION SERVICE.
M. J. Eubanks, and F. Keeter.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 27-36, 3 fig, 1 tab, 9 ref.

Descriptors: *Mississippi, *Sediment control, *Sedimentation, *Water resources management, *Watershed management, Alabama, Channel erosion, Erosion, Erosion control, Flood plain management, River basins, Sediment transport, Soil management.

A joint study of the Tombigbee River Basin, Mississippi and Alabama, is being conducted by the U.S. Army Corps of Engineers, Mobile District (Corps) and U.S. Department of the Agriculture, Soil Conservation Service (SCS). As part of this study, the East Fork Basin Study was initiated in March, 1989, to address resource problems in a systematic manner, and has been evaluated at a preliminary level. The major resource issues identified in the East Fork Basin Study area are related to sedimentation: significant erosion of farmland; unstable stream channels and banks; sediment and debris accumulation in the tributaries and adjacent flood plains; declining populations of endangered mussel species; gravel mining; water supply withdrawal; sedimentation in the navigation channel; and flooding. The first step in development of measures to address the sedimentation issues was the delineation of the major erosion problem areas. It was computed that the gross soil loss from overland sources is 1,755,484 tons per year and approximately 80% of the sediment being transported by the tributary streams comes from streambed and bank erosion. The Corps and SCS have developed measures to address the sedimentation and erosion problems in the East Fork Basin, including stream channel grade control structures, bank protection, land treatment, flood sediment control structures, minor grade control structures, and filter strips. Incremental improvement could be realized by phasing implementation in a prioritized manner, as funds are made available. (See also W91-05137) (Fish-PTT)
W91-05139

IMPROVING ESTIMATES OF LOW-FLOW CHARACTERISTICS FOR STREAMFLOW STATIONS AFFECTED BY CLIMATIC CYCLES.
P. A. Telis.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 37-40, 1 fig, 2 ref.

Descriptors: *Climatic changes, *Climatology, *Flow characteristics, *Hydrologic cycle, *Low flow, *Mississippi, *Rainfall-runoff relationships, *Streamflow data, *Streamflow forecasting, Annual streamflow, Climatic data, Estimating equations, Flow models, Gaging stations, Statistical analysis, Stream discharge.

Knowledge of the magnitude and frequency of low flows for streams is important for water-supply planning, waste-load allocation, storage-facility design, and maintenance of quantity and quality of water for irrigation, recreation, and wildlife conservation. A low-flow characteristic is defined as the minimum average discharge for a selected consecutive-day period for a given recurrence interval in years. Comparisons of the annual 7-day low-flow series for long periods of record (1899-1987) at streamflow gaging stations in Mississippi and the statewide rainfall data for the period 1900-86 show that cyclic patterns of streamflow correspond to cyclic patterns of rainfall. Generally, statewide rainfall for the mid-1950s was lower than average and rainfall in the mid-1970s was higher than average. A statistically unbiased method for estimating low-flow characteristics was used to compute improved estimates of the mean and standard deviation of the annual low-flow series at the short-term station based on these correlations. Improved low-flow characteristics adjusted for climatic cycles in low-flow data were computed using the adjusted stations statistics and the log-Pearson Type III frequency equation. Improvement of estimates of low-flow characteristics for stations affected by climatic cycles was verified by a comparison of the standard errors of estimate of the low-flow characteristics computed with and without adjustments. (See also W91-05137) (Fish-PTT)
W91-05140

EFFECTS OF CLEARING AND SNAGGING ON PHYSICAL CONDITIONS OF RIVERS.
Memphis State Univ., TN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W91-05141

EFFECTS OF RECORD HIGH MEAN MONTHLY STREAMFLOWS IN SELECTED STREAMS NORTH MISSISSIPPI IN 1989.
L. G. Long.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 52-58, 3 fig, 2 tab, 4 ref.

Descriptors: *Agricultural watersheds, *Flood damage, *Flood plain management, *Mississippi, *Rainfall-runoff relationships, *Stream discharge, Crop damage, Deltas, Excess rainfall, Flood control, High flow, Interagency cooperation.

Flooding problems continue to plague the agricultural sectors in many parts of Mississippi, even though numerous flood control projects have been installed. Record high mean monthly streamflows were experienced in selected streams in northern Mississippi during May through July 1989, due to the excessive rainfall occurring during this period. The streams studied were Big Sunflower River, the Yazoo-Tallahatchie-Coldwater Rivers Delta area, and the Big Black River. Rainfall in the Upper Delta, North Central, and Central Regions was excessive during the period of January through July 1989. Mississippi suffered devastating damages and crop losses over the entire state in 1989 due to flooding caused by sustained high streamflows as a result of the excessive rainfall amounts. Not only was the agricultural community affected, but state and county roads and bridges sustained extensive damages, and many homes were also inundated. It is concluded that it would not be practical to attempt to design and construct channels and levee systems to flood-proof floodplains for major storm events as experienced in 1989. The cooperation of federal and state agencies along with the private sector in coordinating and implementing the State Water Management Plan, mandated by the existing state statutes, could possibly lessen the impact of major floods. (See also W91-05137) (Fish-PTT)
W91-05142

UPSTREAM EXTENT OF SALINE WATER IN THE PASCAGOULA RIVER.
For primary bibliographic entry see Field 6G.
W91-05148

INTERACTION BETWEEN YAZOO RIVER AND MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER SYSTEM.
For primary bibliographic entry see Field 2F.
W91-05152

STABILITY OF FREE SURFACE SEDIMENT FLOW.
California Univ., San Diego, La Jolla. Inst. for Nonlinear Science.
For primary bibliographic entry see Field 2J.
W91-05170

POST-SPATE DEVELOPMENT OF EPILITHIC ALGAL COMMUNITIES IN DIFFERENT CURRENT ENVIRONMENTS.
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-05190

HABITAT-SPECIFIC SOLUTE RETENTION IN TWO SMALL STREAMS: AN INTERSITE COMPARISON.
Georgia Univ., Athens. Inst. of Ecology.
For primary bibliographic entry see Field 2K.
W91-05201

HYDROLOGIC INFLUENCES, DISTURBANCE, AND INTRASPECIFIC COMPETITION IN A STREAM CADDISFLY POPULATION.
California Univ., Berkeley. Dept. of Entomological Sciences.
For primary bibliographic entry see Field 2H.
W91-05202

NUMERICAL MODELING OF HYDRODYNAMICS. BRAZOS ISLAND HARBOR PROJECT, TEXAS (BROWNSVILLE SHIP CHANNEL).
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
L. M. Hauck, and B. Brown.
Available from the National Technical Information Service, Springfield, VA 22126361. Technical Report HL-90-5, September 1990. Final Report. 55p, 10 fig, 11 plates, 13 ref, append.

Descriptors: *Model studies, *Navigation channels, *Mathematical models, *Hydrodynamics, *Brazos Island Harbor, *Texas, *Brownsville Ship Channel, *Data interpretation, Mathematical studies, Navigation, Water level, Flow velocity, Channel flow, Simulation analysis, Tidal hydraulics.

The Brazos Island Harbor Project, south Texas, has been authorized for navigation channel improvements, which include deepening the Brownsville Ship Channel. A vertically integrated two-dimensional numerical model RMA-2V is being used to simulate the Brownsville Ship Channel and the lower Laguna Madre. RMA-2V was used to produce the hydrodynamics (water levels and velocities) for existing and three alternative channel designs. These hydrodynamic conditions were used in a ship simulator study. Historical velocity (direction and speed) measurements taken at approximately hourly intervals during the period 15-18 July 1980 at several stations were used to verify RMA-2V. Water level measurements from 4 tide gages were available for the same period to facilitate model verification. Because the Laguna Madre exhibits large response to wind forcing, some of the inaccuracies in water level verification were suspected to be the result of the sparsity of wind speed and direction data in the prototype system for the model verification. The verified RMA-2V model was operated with a high amplitude diurnal (spring) tide with a temporally varying southeast wind at 4 to 20 mph. The wind was phased to increase both the ebb and flow velocities. With these tidal and wind conditions, RMA-2V simulated the hydrodynamics for existing and 3 alternative channel designs. The peak ebb and flood currents for each design were saved as computer files for use in a separate ship simulator study. (Lantz-PTT)
W91-05268

FLOW MONITORING SYSTEM FOR THE VAAL AND WILGE RIVERS.
Department of Water Affairs, Pretoria (South Africa).
For primary bibliographic entry see Field 7B.
W91-05282

CALCULATIONS OF SWINGING OF THE FLOW IN TRAPEZOIDAL CHANNELS.
For primary bibliographic entry see Field 8B.
W91-05314

CALCULATION OF THE CONTROLLING DEPTHS OF DEFORMABLE RIVER CHANNELS.
For primary bibliographic entry see Field 2J.
W91-05315

DO MODEL UNCERTAINTY WITH CORRELATED INPUTS.
Nanjing Univ. (China). Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W91-05327

EVIDENCE FOR LARGE-SCALE SUBGLACIAL MELTWATER FLOOD EVENTS IN SOUTHERN ONTARIO AND NORTHERN NEW YORK STATE.
Queen's Univ., Kingston (Ontario). Dept. of Geography.
J. Shaw, and R. Gilbert.
Geology GLGYBA, Vol. 18, No. 12, p 1169-1172, December 1990. 6 fig, 34 ref.

Descriptors: *Glaciohydrology, *Paleohydrology, *Meltwater, *Geologic history, *Geohydrology, *Flow pattern, *Historic floods, *Regional floods, Ontario, Canada, New York, Flood flow, Glacial sediments, Geologic formations, Structural geology, Data interpretation.

Recent work on drumlins, subglacial tunnel channels, and other erosional forms has lead to the concept that they were formed by extreme meltwater discharge events from subglacial reservoirs. However, there is much still to be discovered about the direct, subglacial processes of meltwater floods; in particular, the scale of individual events needs to be investigated. Flow-line patterns constructed from the orientation of drumlin long axes were used to infer two major subglacial meltwater floods in southern Ontario, Canada, and northern New York, U.S. In this interpretation, the flood waters of the first event, the Algonquin, surged southward. In the later, Ontarian event, powerful floods streamed southwestward along the basins of Lakes Ontario and Erie. Bedrock fluting, upstream-pointing noses on escarpments, and tunnel channels give supporting evidence for the regional flood hypothesis. Regional distributions of drift thickness may be explained by this hypothesis. (Author's abstract)
W91-05367

FLOODS THREATENING KASHMIR WETLANDS.
Kashmir Univ., Srinagar (India). Centre of Research for Development.
A. K. Pandit, and S. Qadri.
Journal of Environmental Management JEVMAW, Vol. 31, No. 4, p 299-311, Dec 1990. 9 fig, 4 tab, 23 ref.

Descriptors: *Environmental effects, *Flood damage, *India, *Sediment control, *Silting, *Soil erosion, *Wetlands, *Wildlife habitats, Agricultural practices, Aquatic habitats, Environmental protection, Flood control, Flood plain zoning, Himalayan Mountains, Kashmir, Waterfowl.

The wetlands of the Kashmir Himalaya have been made inhospitable by recurring flooding, caused in part by heavy spring rains concurrent with snowmelt. These conditions have been exacerbated by increased settlement and agricultural practices near these areas which increase runoff and erosion. The sediment load is carried into the low-lying wetland areas and settles out. As a result of heavy deposits of silt, many important species of plants and animals have vanished and many more are losing their habitats: in contrast, however, a few new species are appearing and spreading fast. The destruction caused by flood waters and sediment deposition is detrimental to many species of water-birds inhabiting the wetlands. Adequate flood control measures such as the construction of inflow and outflow gates, reservoirs and settling basins, earthen boundaries, reducing deforestation, maintaining plant cover, restricting housing, diversion of flood waters, and flood warning programs are essential to ensure the survival of these productive ecosystems. (Doyle-PTT)
W91-05385

FRAMEWORK FOR INCORPORATING STREAM USE IN THE DETERMINATION OF PRIORITY WATERSHEDS.
Wisconsin Univ.-Green Bay. Coll. of Environmental Sciences.
For primary bibliographic entry see Field 6D.
W91-05386

NATURE OF DISSOLVED ORGANIC MATTER IN THE DRAINAGE BASIN OF A BOREAL HUMIC RIVER IN NORTHERN FINLAND.
Oulu Univ. (Finland). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-05394

TURBULENT STRUCTURE IN COMPOUND OPEN-CHANNEL FLOWS.
Nagoya Inst. of Tech. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8E.

W91-05420

SIMULATION OF FLOOD WAVES FROM OUTBURST OF GLACIER-DAMMED LAKE.
Instituto Nacional de Ciencia y Tecnica Hidricas, Mendoza (Argentina).
P. C. Fernandez, L. Fornero, J. Maza, and H. Yanez.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 42-53, January 1991. 8 fig, 5 tab, 21 ref.

Descriptors: *Dam failure, *Flood forecasting, *Flood routing, *Flood waves, *Glacial lakes, *Glacier surges, *Glaciohydrology, *Model studies, Andes Mountains, Flood hydrographs, Historic floods, Ice jams, Mathematical models, Maximum probable floods, Simulation analysis.

On the upper watershed of the Mendoza River, at elevations higher than 4,000 m above sea level and close to the Argentine-Chilean border, a group of glaciers associated with winter snowfall are the main runoff sources. The Grande del Nevado del Plomo glacier periodically produces a surge and an ice dam that confines the Plomo River Valley and forms a glacier-dammed lake. The outflow of the ice dam and the routing of flood waves downvalley were studied by means of hydrologic and hydraulic mathematical simulation for flood-wave forecasting, the operating of a real-time hydrologic alert system, and determination of inundation maps, as well as the study of the impact on diversion dams, bridges, roads, and railroads along the river. All calculations and results were compared with measured discharges for the calibration of the models. Outburst hydrographs were based on the observation of the elevation-time data for the lake-water surface during the emptying of the lake. Monitoring emptying conditions with hydrometeorological telemetering at two points along the river verified the consistency of generated hydrographs. The DAMBRK model simulated the ice-dam break with physical restrictions in the occurrence of the breach and may be used to simulate the translation of the dynamic wave along the river. Since the results of the study are based on a limited number of historic flood events, they should be used cautiously for engineering studies of ice-dam outbursts. (Geiger-PTT)
W91-05421

SUPERCRITICAL FLOW IN SMOOTH OPEN CHANNELS.
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-05422

FORCE ON SLAB BENEATH HYDRAULIC JUMP.
Urmia Univ. (Iran). Dept. of Irrigation.
For primary bibliographic entry see Field 8B.
W91-05423

EFFECT OF ROUGHENED-BED STILLING BASIN ON LENGTH OF RECTANGULAR HYDRAULIC JUMP.
Toyohashi Univ. of Technology (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-05424

RESISTANCE IN FLAT-BED SEDIMENT-LADEN FLOWS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
D. A. Lyn.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 94-114, January 1991. 9 fig, 3 tab, 28 ref. NSF Grants CEE-7920311 and MSM-8611127.

Descriptors: *Flow friction, *Flow resistance, *Open-channel flow, *Reynolds number, *Sediment transport, *Suspended load, *Suspended sediments, Flow measurement, Fluvial sediments, Hydraulic models, Mathematical models, Open channels, Roughness coefficient, Shear stress.

The effect on flow resistance in uniform flat-bed open-channel flows due to suspended sediment was investigated. Flows with and without an equilibrium sand bed were studied in a laboratory channel using three well-sorted natural sands. Point velocity measurements, as well as estimates of local wall shear, were obtained with a laser-Doppler anemomentry system, and were used to evaluate friction factors. Results indicated that, contrary to recent models, the presence of suspended sediment does not necessarily lead to a reduction in flow resistance, but will generally result in an increase. In general, local velocities in sediment-laden flows near the bed are reduced relative to the equivalent clear-water flow. In the range of experimental conditions considered this reduction dominates and leads to increased flow resistance, perhaps up to 25%-50% in saturated equilibrium-bed cases. In cases where a notable increased flow resistance was not found, the reduction in near-bed velocities was compensated by increased velocities in the outer flow. This is usually associated with high-transport, heavy suspended-load flows. (Geiger-PTT)
W91-05425

BED FEATURES IN NONUNIFORM SEDIMENTS.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
Y. M. Chiew.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 116-120, January 1991. 3 fig, 1 tab, 5 ref.

Descriptors: *Bed load, *Channel morphology, *Entrainment, *Fluvial sediments, *Sediment transport, *Sediment-water interfaces, Flow friction, Flow resistance, Flow velocity, Froude number, Particle size, Shear stress.

The formation of bed features in nonuniform sediments was studied under dynamic equilibrium conditions in a recirculating flume. Seven sets of sediment with the same mean particle size but different geometric standard deviation were used. Each of these sediments was subjected to a uniform flow with depth equal to 170 mm. The approach flow velocity was varied systematically from 0.3 to 2 m/sec. The bed of the flume was adjusted for each flow condition to ensure a uniform flow. The energy slope was measured for computation of bed shear stresses. Each of the experiments was run until equilibrium. The size of the bed features formed at lower velocity is related to the availability of fine sediment on the bed surface. At high velocity, when all the grains in the mixture are mobile, the preferred bed form is transition flat bed. Experiments show that antidunes did not form for geometric standard deviation greater than 2.3, even though the Froude number had exceeded unity. The inhibition of antidunes formation is presumably caused by the presence of a pavement or dynamic armored layer. (Geiger-PTT)
W91-05426

PARAMETER ESTIMATION FOR SEASONAL TO SUBSEASONAL DISAGGREGATION.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-05431

ANNUAL AND SEASONAL FLUCTUATIONS OF PRECIPITATION AND STREAMFLOW IN THE ACONCAGUA RIVER BASIN, CHILE.
Florida Univ., Gainesville. Dept. of Geography.
For primary bibliographic entry see Field 2B.
W91-05432

ESTIMATION OF THE GEV DISTRIBUTION FROM CENSORED SAMPLES BY METHOD OF PARTIAL PROBABILITY WEIGHTED MOMENTS.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
Q. J. Wang.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 103-114, December 1990. 1 fig, 3 tab, 6 ref, append.

Descriptors: *Data interpretation, *Flood forecasting, *Flood frequency, *Maximum probable floods, *Rainfall-runoff relationships, *Statistical analysis, *Statistical methods, *Statistics, Arid lands, Historic floods, Mathematical studies, Monte Carlo method, Probability distribution, Semiarid lands.

The concept of partial probability weighted moments (PPWM), which can be used to estimate a distribution from censored samples, is becoming widely used in flood frequency analysis to estimate parameters and quantiles of a distribution from systematic flood records. The method can also be used to estimate parameters and quantiles of a distribution from systematic and historical information. Unbiased estimators of PPWM from systematic and historical information were formulated. Parameters and quantiles of the generalized extreme value (GEV) distribution were estimated from systematic and historical information. Monte Carlo experiments showed that historical information is most useful for estimating high quantiles when a distribution has a thick tail and less useful when a distribution has a thin or bounded tail. Unbiased estimators of PPWM from a systematic record censored on low values and with historical information were also derived. An application was made to estimating the GEV distribution. Monte Carlo experiments showed that by increasing the lower bound censoring threshold for the systematic record, standard error and mean square error or high quantile estimates are increased by only a very small amount. This could be a very useful technique for dealing with the undesirable effects of low outliers which occur in semiarid and arid zones. (Author's abstract)
W91-05433

UNBIASED ESTIMATION OF PROBABILITY WEIGHTED MOMENTS AND PARTIAL PROBABILITY WEIGHTED MOMENTS FROM SYSTEMATIC AND HISTORICAL FLOOD INFORMATION AND THEIR APPLICATION TO ESTIMATING THE GEV DISTRIBUTION.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
Q. J. Wang.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 115-124, December 1990. 4 tab, 7 ref.

Descriptors: *Data interpretation, *Flood forecasting, *Flood frequency, *Maximum probable floods, *Statistical methods, *Statistics, Historic floods, Mathematical studies, Monte Carlo method, Probability distribution, Statistical analysis.

The method of probability weighted moments (PWM) is becoming widely used in flood frequency analysis to estimate parameters and quantiles of a distribution from systematic flood records. This method can also be used to estimate parameters and quantiles of a distribution from systematic and historical information. Unbiased estimators of PWM from systematic and historical information have been formulated and applied to estimating any distribution for which a PWM estimation scheme is available. An application was made to estimate parameters and quantiles of the generalized extreme values (GEV) from systematic and historical information. Monte Carlo experiments have shown that historical information is most useful for estimating high quantiles when a distribution has a thick tail and less useful when a distribution has a thin or bounded tail. Unbiased estimators of partial probability weighted moments (PPWM) from a systematic record censored on low values and with historical information were also derived. An application was made to estimating the GEV distribution. Monte Carlo experiments showed that by increasing the lower bound censoring threshold for the systematic record, standard error and mean square error of high quantile estimates are increased by only a very small amount. (Geiger-PTT)
W91-05434

CRITICAL DROUGHT ANALYSIS BY SECOND-ORDER MARKOV CHAIN.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
Z. Sen.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 183-202, December 1990. 16 fig, 2 tab, 12 ref.

Descriptors: *Data interpretation, *Drought, *Markov process, *Statistical analysis, *Statistics, Annual precipitation, Danube River, Hydrologic models, Mississippi River, Probabilistic process, Probability distribution, Rhine River, Simulation analysis, Statistical methods, Streamflow.

Exact probability distribution functions (PDF) of critical droughts in stationary second-order Markov chains are derived for finite sample lengths on the basis of the enumeration technique. These PDF are useful in predicting the possible critical drought durations that may results from any hydrologic phenomenon during any future period provided that the second-order Markov chain is representative of the underlying probability generation mechanism. Necessary charts are provided for the expectation and variance of critical droughts. The application of the developed methodology is given for three representative annual flow series from different parts of the world (Mississippi, Danube, and Rhine Rivers). The critical droughts of these sites conform well with the second-order Markov chain. The longest drought duration probability is dependent on the sample size, truncation level and the transitional probabilities, but is independent of the PDF of the hydrologic phenomenon. The transitional probabilities reflect the dependence structure of the phenomenon concerned. Provided that the sample size, truncation level and corresponding transitional probabilities are known, one can easily evaluate the risk or probability of critical drought occurrence from the present analytical formulation. The analytical formulations make it possible to find the probabilistic and stochastic properties of critical drought durations without resorting to Monte Carlo simulation techniques, which are cumbersome and expensive. (Author's abstract)
W91-05438

HUANGHE (YELLOW RIVER) AND ITS ESTUARY: SEDIMENT ORIGIN, TRANSPORT AND DEPOSITION.
Ocean University of Qingdao, 5 Yushan Road, 266003 Qingdao, People's Republic of China.
For primary bibliographic entry see Field 2J.
W91-05439

FORMATION, COLONIZATION AND FATE OF FLOATING SUDDS IN THE MAUNACHIRA RIVER SYSTEM OF THE OKAVANGO DELTA, BOTSWANA.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-05485

TROPICAL HYDROLOGY AND CARIBBEAN WATER RESOURCES.
For primary bibliographic entry see Field 2A.
W91-05611

ARMA MODEL FOR RAINFALL-RUNOFF WITH APPLICATIONS.
Kansas Univ., Lawrence. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W91-05620

PARAMETER ESTIMATION IN CONCEPTUAL PRECIPITATION-RUNOFF MODELS WITH EMPHASIS ON ERROR ANALYSIS.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
For primary bibliographic entry see Field 2B.
W91-05621

AUTOMATIC PARAMETERS CALIBRATION TECHNIQUE FOR RAINFALL-RUNOFF MODELLING.
National Cheng Kung Univ., Tainan (Taiwan). Dept. of Hydraulics and Ocean Engineering.
For primary bibliographic entry see Field 2B.
W91-05622

GEOGRAPHIC DISTRIBUTION OF DROUGHT ON TWO CARIBBEAN ISLANDS: PUERTO RICO AND ST. KITTS.
Morris (Gregory L.) and Associates, San Juan, PR.
G. L. Morris, and M. Vazquez.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 141-150, 5 fig, 1 tab, 1 ref.

Descriptors: *Distribution patterns, *Drought, *Puerto Rico, *Rainfall, *St Christopher and Nevis, *Tropical hydrology, *Tropical regions, Caribbean Sea, Data interpretation, Geography, Moisture deficiency, Rain intensity, Statistical analysis, Water deficit.

The geographic variation of drought intensity was examined in Puerto Rico and St. Kitts, representative of one of the larger and the smaller volcanic islands in the Caribbean. Monthly rainfall data were utilized for the period 1950-1986 for 30 stations in Puerto Rico and 8 in St. Kitts. A 9 month drought intensity index representing the cumulative percentage departure of actual 9 month rainfall from the normal, was computed for every month. Station to station scatter plots indicated that periods of moisture deficit and excess were well-correlated across all of St. Kitts, but poor correlation was the rule in Puerto Rico. The drought index values were plotted for each island for the most severe drought of record. Whereas all of St Kitts was simultaneously affected by serious drought, in Puerto Rico parts of the island experienced extreme drought (a cumulative 9 month deficit exceeding 50% of normal rainfall), whereas other parts of the island were only sightly affected. This information can assist in evaluating the benefits of long distance water transmission systems connecting geographically diverse basins. (See also W91-05611) (Author's abstract)
W91-05626

ROLE OF TEMPERATURE FOR DROUGHT STUDY.
Ohio Univ., Athens. Dept. of Civil Engineering.
T. J. Chang.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 151-166, 6 fig, 1 tab, 12 ref. US Army Corp of Engineers Agreement EO-W-8160-030.

Descriptors: *Climatology, *Drought, *Meteorology, *Moisture deficiency, *Temperature effects, *Time series analysis, *Tropical hydrology, *Water deficit, Mathematical studies, Ohio, Poisson ratio, Rainfall, Scioto River Basin, Soil water, Streamflow.

Drought has been defined in many ways using different hydrologic indicators, such as meteorological drought using precipitation, hydrologic drought using streamflow, and agricultural drought using soil moisture. Daily maximum temperatures were used to define events of a prolonged period of water deficiency. Assuming that occurrences of such events can be interpreted by the time-dependent Poisson process, the intensity function is derived to investigate their properties for the studied region. Several truncation levels, namely, 70%, 80%, 90%, and 95% were applied to daily temperature time series. The period of the cycle increases as the truncation level increases: roughly 180 days for 50%, 330 days for 70%, 380 days for 80%, and 400 days for 90%. Based on the data from 13 gage stations in the Scioto River Basin in Ohio, it was found that there is an apparent trend of increasing drought intensity in the region. (See also W91-05611) (Author's abstract)
W91-05627

CULVERT FLOW IN SMALL DRAINAGES IN MONTANE TROPICAL FORESTS: OBSERVATIONS FROM THE LUQUILLO EXPERIMENTAL FOREST OF PUERTO RICO.
Institute of Tropical Forestry, Rio Piedras, PR.
F. N. Scatena.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 237-246, 4 fig, 3 tab, 10 ref.

Descriptors: *Culverts, *Flow profiles, *Luquillo Experimental Forest, *Mountain streams, *Puerto Rico, *Tropical hydrology, *Tropical regions, Drainage systems, Drainage water, Flow control, Forest watersheds, Hydraulic properties, Surface drainage.

During unsubmerged flow conditions, water-level measurements in culverts can provide accurate estimates of stream discharge for small-watershed studies. However, these culverts should have inlet-controlled flow as all expected discharges, and individual stage/discharge relationships should be developed for both submerged and unsubmerged flow conditions. The hydraulics of 5 culverts in the Luquillo Experimental Forest of Puerto Rico are described using a general equation based on empirical data which estimates culvert discharge during unsubmerged conditions. The equation is consistent with published experimental and theoretical work and can be used to estimate culvert size needed to pass flows of given return frequencies. Larger culverts are needed in humid tropical montane areas than in humid temperate watersheds and are usually appropriate only for drainages less than 1 sq km. However, since culvert size is an exponential function of flow frequency, the cost of designing for 25-year flows is not appreciably greater than the costs associated with culverts based on 10-year flows. (See also W91-05611) (Author's abstract)
W91-05635

REGIONAL EQUATIONS TO DETERMINE PEAK STREAM DISCHARGES IN THE SANTANDER REGION, COLOMBIA.
Universidad Industrial de Santander, Bucaramanga (Colombia). Dept. de Ingenierria Civil.
B. Aramburo, and L. Gavilan.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 247-255, 6 tab, 7 ref.

Descriptors: *Colombia, *Design flow, *Flood forecasting, *Flood peak, *Stage-discharge relations, *Stream discharge, *Tropical hydrology, Case studies, Computer programs, Data interpretation, Hydraulic properties, Mathematical analysis, Mathematical equations, Santander, Statistical analysis.

The determination of maximum flows for different return intervals in a watershed is one of the design parameters normally required in hydraulic engineering. Hydraulic projects in tropical countries often lack the hydrologic data necessary for predicting maximum flows for a given return interval; making it necessary to transpose existing data from elsewhere in the region using a procedure that produces an acceptably low error. This is the case in the state of Santander, Colombia, where the 11 available gage stations in an area of 65000 sq km, are used to predict flows for different return periods using Gumbel's first distribution and Log-Pearson Type III distribution. A Chi-square test is used. Regression analysis and geomorphological characteristics of the watershed, such as area, main chan-

nel length and mean basin slope, are used to fit regional equations for different return periods. Results show that this method is suitable for predicting flood flows in Santander. A computer package has been developed to generate regional equations for the state of Santander. The package can also be used to generate similar equations for other tropical regions with high precipitation. (See also W91-05611) (Author's abstract)
W91-05636

BASELINE WATER-QUALITY EVALUATION OF THREE BASINS IN THE UPPER RIO GRANDE DE ARECIBO BASIN, PUERTO RICO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-05655

ANNUAL RUNOFF ESTIMATION FOR CATCHMENTS IN INDIA.
Roorkee Univ. (India). Dept. of Civil Engineering.
U. C. Kothyari, and R. J. Garde.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 1-10, 1991. 4 fig, 2 tab, 13 ref.

Descriptors: *Annual runoff, *India, *Rainfall-runoff relationships, *Runoff forecasting, *Water yield, *Watershed management, Forest watersheds, Hydrologic cycle, Temperature effects, Variation coefficient, Water resources planning.

Estimates of annual runoff are needed for planning water resources projects. However, there is a lack of long-period runoff records in a large number of catchments in India. In the absence of detailed data, use of regional relationships can be made for hydrologic planning. Data from 55 non-snowfed catchments in the Indian subcontinent, having an area greater than 347 sq km, were analyzed to study the influence of selected climatic, topographic, and land-use variables on the mean annual runoff. The mean annual rainfall, mean annual temperature, and vegetal (forest) cover factor were the most important variables influencing the mean annual runoff. Forest cover was positively correlated with mean annual runoff from large catchments, and a relationship was also found between the coefficient of variation and annual rainfall and the coefficient of variation of annual runoff. Making use of the fact that the annual runoff follows the normal frequency distribution, one can generate annual runoff series for the required. These results will be useful for planning water resources projects in India. (Author's abstract)
W91-05786

TESTING STOCHASTIC DYNAMIC PROGRAMMING MODELS CONDITIONED ON OBSERVED OR FORECASTED INFLOWS.
Bureau of Environmental Protection, Taipei (Taiwan).
W.-C. Huang, R. Harboe, and J. J. Bogardi.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 28-36, 1991. 1 fig, 2 tab, 11 ref.

Descriptors: *Channel inflow, *Dynamic programming, *Model studies, *Reservoir operation, *Stochastic models, Model testing, Simulation analysis, Taiwan, Water resources management.

Four types of stochastic dynamic programming (SDP) were compared for on-line reservoir operation, relying on observed or forecasted inflows. The models are different because of the assumptions regarding the inflow in the next time period. If this inflow is known (or a forecast is possible with 100% reliability) models with expected value of the future returns are possible (present returns are deterministic). Otherwise, a simple forecast based on conditional probabilities is necessary, and present and future returns are random. The objective is to maximize expected annual hydropower generation. In a case study of the Feitsui Reservoir in Taiwan, SDP models appeared to provide efficient long-term operating policies. The simulation of on-line operation of the reservoir revealed that the SDP model that relies on the observed inflows of the preceding time step provided the best performance. Nevertheless, under different hydrological regimes this finding might be not universal, but dependent upon the characteristics of the particular water resources system. (Author's abstract)
W91-05788

GROWTH OF ALTERNATE BARS IN UNSTEADY FLOW.
Genoa Univ. (Italy). Inst. of Hydraulics.
For primary bibliographic entry see Field 2J.
W91-05835

LIGHT STABLE ISOTOPE SYSTEMATICS OF LARGE-SCALE HYDROLOGIC REGIMES IN CALIFORNIA AND NEVADA.
California Univ., Davis. Dept. of Geology.
For primary bibliographic entry see Field 2A.
W91-05838

NONPARAMETRIC VARIABLE KERNEL ESTIMATION WITH HISTORICAL FLOODS AND PALEOFLOOD INFORMATION.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
S. L. Guo.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 91-98, January 1991. 6 fig, 4 tab, 16 ref.

Descriptors: *Flood forecasting, *Flood recurrence interval, *Floods, *Nonparametric methods, *Paleohydrology, *Statistical methods, Mathematical studies, Probability density functions, Time series analysis, Variable kernel estimation.

Traditional flood frequency analysis methods are based mainly on the assumption that the observed sample comes from a population whose probability density function is known. Extending a data record back in time using historical or paleoflood data has the potential to provide a considerable amount of information on very large floods. Parametric estimation methods are readily applicable to flood frequency analysis when historical or paleoflood estimates are available. However, all parametric approaches need an assumption about the underlying parent distribution, which is never known exactly. In recent years nonparametric methods of estimating probability density functions have been developed. Each of these involves the use of a suitable smoothing function known as a kernel. A new nonparametric variable kernel estimation has been developed. Results obtained from a limited amount of real data and from simulation experiments show that quantiles estimated by this nonparametric method are better than those estimated by some selected parametric models, both in descriptive ability and in predictive ability. Experiments with Monte Carlo methods showed that the nonparametric approach is competitive with parametric models, and it results in small bias and root mean square error in quantile estimation. The nonparametric method does not require that any particular form of density function be assumed. This allows the annual maximum flood series to 'speak for themselves' (i.e., probability density function estimated directly from the sample). Like the maximum likelihood framework in parametric models, the nonparametric model also depends on the threshold value. Generally, the nonparametric method places a strong weighting on the flood magnitudes near the specified discharge, x. In contrast, the parametric approach uses both historical and systematic information about the annual maxima distribution as a whole. The results run counter to hydrologic intuition. (Rochester-PTT)
W91-05839

MONTE CARLO STUDY OF RAINFALL SAMPLING EFFECT ON A DISTRIBUTED CATCHMENT MODEL.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
W. F. Krajewski, V. Lakshmi, K. P. Georgakakos, and S. C. Jain.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 119-128, January 1991. 7 fig, 2 tab, 44 ref. NSF Presidential Young Investigator Award CES-8657526 and U.S. Army Corps of Engineers Contract DACA89-87-K-004.

Descriptors: *Flood forecasting, *Hydrologic models, *Network design, *Rainfall distribution, *Rainfall-runoff relationships, *Runoff forecasting, Catchment areas, Design criteria, Hydrographs, Mathematical models, Monte Carlo method, Overland flow, Sampling, Soil Conservation Service, Spatial distribution, Stochastic models, Streamflow, Temporal variation.

Distributed hydrologic models offer advantages over traditional lumped models, but before distributed hydrologic models can be widely used several important questions remain to be answered. A Monte Carlo study of a physically based, distributed-parameter hydrologic model was performed. The catchment model simulates overland flow and stream flow, and it is based on the kinematic wave concept. Soil Conservation Service curves are used to model rainfall excess within the basin. The model was applied to the Ralston Creek watershed, a 7.5-sq km rural catchment in eastern Iowa. Sensitivity of the model response with respect to rainfall-input spatial and temporal sampling density was investigated. The input data were generated by a space-time stochastic model of rainfall. The generated rainfall fields were sampled by the varied-density synthetic rain gage networks. The basin response, based on 5-min increment input data from a network of high density, with about 1 gage per 0.1 sq km, was assumed to be the 'ground truth,' and other results were compared against it. A simple lumped parameter model based on the unit hydrograph concept also was included in the study. Results were interpreted in terms of hydrograph characteristics such as peak magnitude, time-to-peak, and total runoff volume. The results indicate a higher sensitivity of basin response with respect to the temporal resolution than to the spatial resolution of the rainfall data. Also, the frequency analysis of the flood peaks shows severe underestimation by the lumped model. This may have implications for the design of hydraulic structures. (Author's abstract)
W91-05842

DIAGNOSTICS AND PREDICTION OF ANOMALOUS RIVER DISCHARGE IN NORTHERN SOUTH AMERICA.
Wisconsin Univ., Madison. Dept. of Meteorology.
S. Hastenrath.
Journal of Climate JLCLEL, Vol. 3, No. 10, p 1080-1096, Ocotober 1990. 12 fig, 7 tab, 31 ref. National Science Foundation Grant ATM-8722410.

Descriptors: *Climatic data, *Data interpretation, *Prediction, *Rainfall-runoff relationships, *River forecasting, *South America, Atmospheric pressure, Discharge measurement, Hydrologic cycle, Marine climates, Projects, Regression analysis, Seasonal variation, Southern oscillation, Stream discharge, Tropical regions.

The annual cycles of rainfall and river discharge in northern South America are dominated by the seasonal latitude migration of the intertropical convergence zone. The catchments in the west (Madden, Magdalena, and Orinoco) have their high stands between August and December, while those of the Guyanas (Cuyuni, Essequibo, Surinam, Maroni, and Oyapock) peak between May and July. Anomalously abundant discharge is in almost all catchments (except Orinoco) associated with the high Southern Oscillation phase (defined by anomalously high/low pressure at Tahiti/Darwin), weakened Caribbean tradewinds, and accelerated cross-equatorial southerly flow over the eastern Pacific. In a series of experiments a sharp distinction was kept between a 'dependent' dataset (1940-70, or the part available in the river series) used as a training period and an 'independent' portion of the record (1971-87) reserved for prediction. Stepwise multiple regression models for bimonthly 'seasons' used as input river discharge as regressand, and as regressors, index series of Tahiti minus Darwin pressure difference, equatorial Pacific sea surface temperature PWT, zonal wind component over the Caribbean and meridional

wind component over the eastern equatorial Pacific, all two seasons earlier. The resulting equations were then used to predict the discharge anomalies in the independent dataset 1971-87. There is considerable predictive skill for various rivers/seasons, with the overall best predictability for the low discharge time of year. In particular, for Magdalena 55% and for Essequibo 74% of the interannual variance of January-February discharge during 1971-87 is predictable by this method, in which for Essequibo PWT serves as sole predictor. (Author's abstract)
W91-05861

ENVIRONMENTAL RESEARCH ON TRACE ELEMENTS IN FRESHWATER FISH BY NEUTRON ACTIVATION ANALYSIS.
Korean Inst. of Energy and Resources, Seoul (Republic of Korea).
For primary bibliographic entry see Field 5B.
W91-05897

2F. Groundwater

IDENTIFICATION OF THE BOUNDARIES BETWEEN TWO WATERSHEDS IN A VOLCANIC AREA BY THE SELF-POTENTIAL METHOD (VERIFICATION DE LIMITES DE NAPPES AQUIFERES EN TERRAIN VOLCANIQUE PAR LA METHODE DE POLARISATION SPONTANEE).
Observatoire de Physique du Globe de Clermont-Ferrand (France).
M. Aubert, I. N. Dana, and M. Livet.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 311, No. 8, p 999-1004, October 11, 1990. 3 fig, 1 tab, 9 ref. (English Summary).

Descriptors: *Data acquisition, *France, *Geohydrologic boundaries, *Geophysical surveys, *Self potential surveys, Groundwater, Permeability, Vadose zone, Volcanic springs, Watersheds.

The boundary between two watersheds was investigated using the self-potential method in a volcanic site where the porous volcanic rocks overlay an impermeable granite substratum. The range of self-potential anomalies is related to the thickness of the vadose layer. The site is located in the Chaine des Puys, France and the volcanic rocks are dated at 100,000-7000 years B.P. The rocks consist of lava flows, scoria and cinders. The underground waters flow at the contact between the volcanic rocks and the substratum and the subsidence of the Limagne graben at the East of the fault. The slopes of the valleys locally reach 40 degrees. The limits of watersheds obtained from the self-potential data are near to those obtained previously using data from drillings. It is concluded that the use of the self-potential method gives fast, accurate, and inexpensive information on the limits of watersheds in volcanic areas, where the vadose zone exhibits a permeability of the porous type. (Feder-PTT)
W91-04939

ESTIMATING POROSITY OF PARTIALLY SATURATED SEDIMENTS.
Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 2G.
W91-04940

MECHANISMS CONTROLLING CU, FE, MN, AND CO PROFILES IN PEAT OF THE FILSON CREEK FEN, NORTHEASTERN MINNESOTA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2K.
W91-05050

ANION-EXCHANGE CHROMATOGRAPHY PARTICLE BEAM MASS SPECTROMETRY FOR THE CHARACTERIZATION OF AROMATIC SULFONIC ACIDS AS THE MAJOR ORGANIC POLLUTANTS IN LEACHATES FROM STRINGFELLOW, CALIFORNIA.
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
For primary bibliographic entry see Field 5A.
W91-05073

PROCEEDINGS, TWENTIETH MISSISSIPPI WATER RESOURCES CONFERENCE, 1990.
Mississippi Water Resources Research Inst., Mississippi State.
For primary bibliographic entry see Field 2E.
W91-05137

INTERACTION BETWEEN YAZOO RIVER AND MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER SYSTEM.
J. Cooey.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 122-126, 2 fig, 8 ref.

Descriptors: *Alluvial aquifers, *Dam effects, *Geohydrologic boundaries, *Mississippi, *Recession curve, *Surface-groundwater relations, *Yazoo River, Boundary conditions, Flow control, Groundwater recharge, Hydraulic permeability, Natural flow, Statistical methods.

The Yazoo River, located in the Mississippi River Delta in northwest Mississippi, meanders southwestward over part of the Mississippi River Alluvial Plain to join the Mississippi River at Vicksburg, Mississippi. A study was performed to understand the changes in historical and present hydrologic interactions between the waters of the Yazoo River and Mississippi River Alluvial Aquifer System through analysis of all directly-related data, and to propose the best method for measurement and quantification of actual stream-aquifer boundary conditions. Analysis of recession and low flow were accomplished through recession analysis methods. It was shown that down-cutting and lateral movement by the Yazoo River under natural conditions before 1950 insured continual contact between the sands associated with the alluvial aquifer system and the stream, continually changing the hydraulic boundary between the Yazoo River and the Mississippi River Alluvial Aquifer system. Since 1950, the Yazoo River have approached a more constant yearly flow rate due to flood control structures. Analysis of the recession of 97-days under natural conditions and the 44-day recession under regulated conditions indicate a possible change in the river-aquifer hydraulic boundary. Under natural flow conditions recession analysis is a fairly accurate method for measurement of groundwater recharge into a stream during recession. Once a stream flow is controlled, however, the method actually becomes suspect. Other more direct measurement methods must be used to quantify the stream-aquifer hydraulic boundary. (See also W91-05137) (Fish-PTT)
W91-05152

GROUNDWATER MODELS OF THE MIOCENE AQUIFER SYSTEM IN JONES COUNTY, MISSISSIPPI.
Delta Environmental Consultants, Inc., Tampa, FL.
R. Sturdivant, and D. M. Patrick.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 136-146, 4 fig, 4 tab, 20 ref. Mississippi Water Resources Research Institute Grant Number G1571-04.

Descriptors: *Aquifer systems, *Geohydrology, *Groundwater movement, *Mississippi, *Model studies, *Simulation analysis, *Water resources development, *Well pumping, Borehole geophysics, Depression head, Drawdown, Numerical analysis, Potentiometric surface, Pumping tests, Water table profiles.

A better understanding is needed of the Miocene aquifer system in Jones County, Mississippi, by documenting the historic drawdown of potentiometric surfaces in this region and by developing three-dimensional numerical simulation models of the aquifers. An investigation was performed using data consisting of published information describing pumping tests and water levels (potentiometric surface measurements) and unpublished information such as drilling and borehole geophysical logs. The lower aquifer appears to be capable of sustaining 4 percent annual increases in pumping rates through the first decade of the next century in the Laurel area; however, the development of new pumping centers with similar extraction rates may adversely interfere with the cone of depression. Drawdown history and numerical simulations indicate that the number of wells and the extraction rates in the middle aquifer should be limited. The significance and reliability of numerical simulations are highly dependent on the accuracy and availability of the geologic and hydraulic data upon which the model is constructed. There is a need to conduct additional pumping tests in this region and to monitor more wells for more accurate information on predicted water table elevations. The geologic data upon which the boundary conditions were established are considered to be reliable, particularly in the Laurel area; however, these data are less abundant beyond Laurel. The geologic uncertainties in areas where the Miocene aquifers could be lessened by additional borehole geophysical logs and by continuous cores in strategic locations in the region. (See also W91-05137) (Fish-PTT)
W91-05154

POTENTIOMETRIC SURFACE OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER, 1981-1989.
J. L. Crawford.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 147-155, 6 fig, 4 ref.

Descriptors: *Alluvial aquifers, *Aquifer characteristics, *Geohydrology, *Mississippi, *Model studies, *Potentiometric surface, *Water resources management, Computer models, Digital map data, Finite difference methods, Groundwater movement, Hydraulic conductivity, Precipitation, Transmissivity, Water supply development, Water table decline.

The Mississippi River Valley alluvial aquifer is the principal source of water used for irrigation and fish culture throughout the Mississippi Delta region. Because of the dependence of the Delta on an available water supply from the alluvial aquifer, a finite-difference digital model was developed which can be used to simulate flow in the aquifer, and which will be used as a tool to assist in the management of the water resources in the Delta. Potentiometric maps generated biannually from water levels measured in the Delta since 1981 have been used to monitor seasonal fluctuations and annual changes in the aquifer, and show that significant water level declines have occurred in some areas of the Delta as a result of variation in precipitation, the stages of the Mississippi River, and increased levels of pumping. The center of the Delta has shown the largest rates of decline in the aquifer. A computer model map projecting the potentiometric surface of the alluvial aquifer in 2003 using a pumping rate of 1,900 million gallons per day indicates tremendous water level declines across the Delta. It is imperative that the model be constantly updated and revised so that reliable water levels can be projected. More data concerning such aquifer characteristics as transmissivity and hydraulic conductivity are needed. The areal extent and thickness of the surficial clay layer overlying the alluvial aquifer and grain-size analysis of the alluvial sediments is necessary to identify more precisely the physical properties and hydrology of the alluvial aquifer and to allow for a better understanding of this complex and important system. (See also W91-05137) (Fish-PTT)
W91-05155

NEW STATE GEOLOGIC MAP FOR MISSISSIPPI: A TOOL FOR UPDATING NOMENCLATURE AND DEFINITIONS OF THE STATE'S AQUIFERS AND AQUITARDS.

For primary bibliographic entry see Field 7C.
W91-05158

THREE COMMON MISCONCEPTIONS CONCERNING THE FATE AND CLEANUP OF PETROLEUM PRODUCTS IN SOIL AND GROUNDWATER.
Dragun Corp., Berkley, MI.
For primary bibliographic entry see Field 5B.
W91-05249

ENHANCED BIOREMEDIATION TECHNIQUES FOR IN SITU AND ONSITE TREATMENT OF PETROLEUM CONTAMINATED SOILS AND GROUNDWATER.
C.A.A. Bioremediation Systems, Boston, MA.
For primary bibliographic entry see Field 5G.
W91-05252

BIODEGRADATION OF DISSOLVED AROMATIC HYDROCARBONS IN GASOLINE-CONTAMINATED GROUNDWATERS USING DENITRIFICATION.
San Diego State Univ., CA. Graduate School of Public Health.
For primary bibliographic entry see Field 5G.
W91-05253

CLEANUP OF A GASOLINE CONTAMINATED SITE USING VACUUM EXTRACTION TECHNOLOGY.
Terra Vac, Inc., Princeton, NJ.
For primary bibliographic entry see Field 5G.
W91-05259

AGRICULTURAL CHEMICALS IN RURAL, PRIVATE WATER WELLS IN ILLINOIS: RECOMMENDATIONS FOR A STATEWIDE SURVEY.
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5B.
W91-05280

HYDROGEOTHERMAL THEORY OF EARTHQUAKES--BASIS OF PREDICTION, WARNING SYSTEMS, AND COUNTERACTIONS.
For primary bibliographic entry see Field 8E.
W91-05316

DEVELOPMENT AND USE OF AN ELECTRICAL RESISTIVITY CONE FOR GROUNDWATER CONTAMINATION STUDIES.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W91-05358

SIMULATION OF GROUNDWATER FLOW IN COMPLEX MULTIAQUIFER SYSTEMS: PERFORMANCE OF A QUASI THREE-DIMENSIONAL TECHNIQUE IN THE STEADY-STATE CASE.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
D. L. Rudolph, and E. A. Sudicky.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 590-600, October 1990. 10 fig, 16 ref. Natural Sciences and Engineering Research Council of Canada Operating Grants A7712 and U0508.

Descriptors: *Simulation analysis, *Groundwater movement, *Flow equations, *Three-dimensional models, Steady flow, Numerical analysis, *Model studies, *Aquifer systems, Permeability, Finite element method, Aquitards, Hydraulic conductivity, Data interpretation, *Mathematical models.

The use of numerical models in the fields of geotechnical engineering and water resource management has proven extremely valuable for providing insight into the physical response of natural geologic systems. Classical quasi three-dimensional formulations were studied when applied to steady-state groundwater flow problems in complex, multiaquifer environments. Discontinuities in the aquifer and aquitard units can be accommodated along with partial or complete aquifer dewatering and confined or unconfined flow conditions. Some of the main assumptions underlying classical quasi three-dimensional schemes are scrutinized, including the requirement of a two orders of magnitude permeability contrast between aquifers and aquitards. Performance of the numerical scheme was studied through a series of test problems by comparison with results obtained from a conventional finite element model. It was found that a high degree of accuracy and flexibility was achieved with the extended quasi three-dimensional technique, yet the numerical efficiency inherent in the classical formulation was maintained. By dividing an aquifer into a series of horizontal sublayers, vertical resolution of the flow field can be achieved without resorting to a numerically intensive fully three-dimensional scheme. Because it is possible to compute a three-dimensional representation of the hydraulic head distribution in individual aquifers with the quasi three-dimensional formulation, even in the absence of layers of contrasting hydraulic conductivity, the technique provides a viable alternative to the much more complex fully three-dimensional schemes for a wide variety of groundwater flow problems. (Author's abstract)
W91-05360

LABORATORY MODELLING OF FIELD PERMEABILITY TESTS IN CASED BOREHOLES.
Ecole Polytechnique, Montreal (Quebec).
R. P. Chapuis, M. Soulie, and G. Sayegh.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 647-658, October 1990. 14 fig, 2 tab, 55 ref. Natural Sciences and Engineering Research Council of Canada Grant U-0502.

Descriptors: *Groundwater movement, *Aquifer testing, Laboratory methods, Data acquisition, Hydraulic models, *Model studies, *Permeability, *Boreholes, *Hydraulic conductivity, *Soil water, Groundwater pollution, Groundwater movement, Field tests, Piezometers, Soil properties, Piezometric head, Flow equations, Model testing, Seepage, Canada.

A knowledge of the in situ hydraulic conductivity of soils is important when studying problems such as seepage through dams and their foundations, infiltration from disposal fields, and monitoring groundwater contamination. Hydraulic conductivity may be determined by field permeability tests performed in boreholes and piezometers. However, field execution details are known to significantly affect test results. Field permeability tests in cased boreholes were modelled in a sand tank with controlled and measured hydraulic conditions. The testing program included 'end of the casing' and 'Lefranc' tests, as described in Canadian standards 2501-135 and 2501-130, for field permeability tests in a casing driven in a granular soil. The theoretical solutions for these tests require a list of assumptions that may be difficult to satisfy under field conditions. The method for detecting the common error in the assumed piezometric level gave, in all cases, a local piezometric level equal to that determined independently by a set of 22 piezometers. In accordance with the theoretical solutions, the permeability (K) values given by the tests do not depend on the controlled upward or downward seepage in the sand tank. The average K value given by such field tests is strongly influenced by the preparation of the injection zone, which includes a natural soil in a more or less disturbed condition adjacent to an injection aperture or lantern of poorly known geometry and condition, so losses in hydraulic heads there may be different from those assumed in theory. From a practical standpoint, all drilling operations have a major impact on the results and must be strictly controlled to have a reasonable estimate of the K value. (Author's abstract)
W91-05363

ANCIENT SUBAERIAL EXPOSURE AND FRESHWATER LEACHING IN SANDSTONES.
BP Exploration Co. Ltd., London (England).
For primary bibliographic entry see Field 2J.
W91-05368

USA CORN YIELDS, THE EL NINO AND AGRICULTURAL DROUGHT: 1867-1988.
Illinois Univ. at Urbana-Champaign. Dept. of Physics.
For primary bibliographic entry see Field 2B.
W91-05375

EFFECT OF CLIMATE VARIABILITY AND CHANGE IN GROUNDWATER IN EUROPE.
Aarhus County Dept. of the Environment, Hoejbjerg (Denmark).
For primary bibliographic entry see Field 2B.
W91-05382

ELECTROMAGNETIC PROFILING FOR GROUNDWATER IN PRECAMBRIAN BASEMENT COMPLEX AREAS OF NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Geology.
A. I. Olayinka.
Nordic Hydrology NOHYBB, Vol. 21, No. 3, p 205-216, 1990. 7 fig, 16 ref.

Descriptors: *Geophysical surveys, *Geophysical methods, Profiles, *Water resources data, *Hydraulic conductivity, *Groundwater potential, *Nigeria, Electromagnetic waves, Water supply development, Boreholes, Crystalline rocks, Weathering zone, Well yield.

Electromagnetic profiling is now widely used in the selection of borehole sites in areas underlain by crystalline igneous and metamorphic rocks because of its good horizontal resolution of anomalies and cost-effectiveness. Ground electromagnetic profiling, using a Geonics EM34-3 instrument, has been employed to identify areas of high conductivity in a Precambrian basement complex terrain of Nigeria. Field examples, conducted as part of a rural water supply program, were studied. They indicate that the apparent conductivities are generally lower than about 60 mmho/m. Subsequent borehole drilling suggests a good correlation between high EM34 anomalies, deep weathering, and high well yield (>1 L/s). On the other hand, boreholes sited on conductivity lows penetrated a thinner regolith with relatively lower yields. (Fish-PTT)
W91-05384

MOBILIZATION OF COLLOIDS IN GROUNDWATER DUE TO INFILTRATION OF WATER AT A COAL ASH DISPOSAL SITE.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W91-05413

INFLUENCE OF MINERALOGY AND SOLUTION CHEMISTRY ON THE ATTACHMENT OF BACTERIA TO REPRESENTATIVE AQUIFER MATERIALS.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W91-05414

STUDIES OF A SUBARCTIC COASTAL MARSH. III. MODELLING THE SUBSURFACE WATER FLUXES AND CHLORIDE DISTRIBUTION.
Memorial Univ. of Newfoundland, St. John's. Dept. of Geography.
For primary bibliographic entry see Field 2H.
W91-05427

GEOCHEMICAL CALCULATIONS AND OBSERVATIONS ON SALT WATER INTRUSIONS: II. VALIDATION OF A GEOCHEMICAL MODEL WITH LABORATORY EXPERIMENTS.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
C. A. J. Appelo, A. Willemsen, H. E. Beekman, and J. Griffioen.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 225-250, December 1990. 8 fig, 5 tab, 49 ref.

Descriptors: *Analytical methods, *Aquifer characteristics, *Cation exchange, *Geochemistry, *Model studies, *Model testing, *Saline water intrusion, *Sediment chemistry, *Solute transport, Anaerobic conditions, Calcite, Chromatography, Groundwater chemistry, Groundwater movement, Hydrogen ion concentration, Performance evaluation, Separation techniques.

A scheme was developed to validate a multicomponent geochemical transport model. Column experiments were used to study saline-water intrusion into aquifer sediments. The tests maintained the anaerobic status of the sediments from sampling in the field to subsequent laboratory analysis. From two sediments native pore solutions were displaced with strontium chloride solutions; another was percolated alternately with groundwater and once-diluted seawater. The multicomponent transport model was used to represent the chromatographic pattern which develops when exchangeable cations are eluted. Proper description of the SrCl2-elution required reformulation of the cation exchange reaction for one sediment; another showed proton buffering and calcite dissolution with slow kinetics. The Gapon exchange equation was found inappropriate for a multicomponent solution when large elution volumes were required for removal of exchangeable divalent cations; the Gaines and Thomas equation offered a better description. Dissolution of calcite was triggered by proton buffering; substantial increase in exchange capacity was associated with proton buffering even over the small pH increase of from 6.8 to 7.1. These elutions could be modeled with constant exchange coefficients, but during fresh/saltwater displacements the selectivity for Ca/Mg exchange was variable. It is clear that the processes which affect major cation transport in aquifers can now be calculated by computer simulation. An amazingly good fit can be obtained between experiment and model when 'local data' are available. To determine whether this technique has global field applicability, the next step must be to look for field situations where data have been gathered which are adequate for what the transport model can offer. (Geiger-PTT)
W91-05440

WATER-TABLE FLUCTUATIONS IN WEATHERED CRYSTALLINE ROCKS IN A HIGH ALTITUDE HUMID INTERTROPICAL ZONE (HIGH PLATEAUX OF MADAGASCAR) (COMPORTEMENT PIEZOMETRIQUE DES NAPPES D'ALTERITES EN ZONE INTERTROPICALE HUMIDE D'ALTITUDE (HAUTS PLATEAUX DE MADAGASCAR)).
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
J. C. Grillot, M. Raunet, and L. Ferry.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 271-282, December 1990. 6 fig, 9 ref. (English summary).

Descriptors: *Geohydrology, *Groundwater movement, *Hydrologic budget, *Madagascar, *Tropical regions, *Water table fluctuations, Aquifers, Clays, Coastal plains, Confined aquifers, Flooding, Groundwater discharge, Groundwater recharge, Minerals, Piezometric head, Surface-groundwater relations, Water table.

The behavior of rice-cultivated, peaty valley-bottoms on a weathered crystalline schist, located in a high altitude humic intertropical zone (Madagascar) is under study to define the water and mineral balance of these areas with an economic objective. Analysis of the groundwaters' piezometric level on a reference site allowed the differentiation of inflows and outflows and allowed for the specification of the hydraulics of the media. The clay alteration products form a free aquifer broken up by the morphology of the land (valleys, surrounding interfluves). This aquifer discharges by outlets located in the lowlands and thus contributes to the prolonged flooding (nine months a year) of ricefields. Recharge depends on the spatial variability of local precipitation. The granite-gneiss basement constitutes a regional aquifer. The groundwater is semi-confined and outcrops in large valleys with free water tables draining to the low coastal plains of the island. For the most part its recharge is ensured by discontinuous outcrops (residual ridges). The aquifer remains confined for several months after the rainy season. In the lowlands, underlying sands are also water bearing, recharged from superficial flows. The groundwater is confined during the rainy season, which favors ascending flows towards the rice rooting zone. (Author's abstract)
W91-05442

CURVES OF CHEMICAL FLUX VERSUS DISCHARGE AND WORKING OF KARST AQUIFERS (LES COURBES FLUX CHIMIQUE-DEBIT ET LE FONCTIONNEMENT DES AQUIFERES KARSTIQUES).
Centre Univ. d'Avignon (France). Hydrogeology Lab.
J. Mudry.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 283-294, December 1990. 10 fig, 16 ref. (English summary).

Descriptors: *Aquifers, *Geochemistry, *Geohydrology, *Groundwater movement, *Karst, *Karst hydrology, *Water chemistry, *Weathering, Environmental chemistry, Minerals, Seepage.

When integrating both chemical content and discharge in Karst aquifers the chemical flux is a choice parameter, both for the study of water transit and weathering budgets. In a karst system, chemical flux facilitates study of: (1) the main aquifer of the system that supplies springs from high to low flows; (2) the piston-effect of seepage upon highly mineralized waters contained in karst channels; (3) the qualitative passage from a regime of water decline to one of water depletion; (4) several outlets belonging (or not) to the same karst system; (5) the homogeneity mixing in the system, and thus the importance of its karstification; and (6) the heterogeneity of seepage and reserves. (Author's abstract)
W91-05443

ATOLL ISLAND HYDROGEOLOGY: FLOW AND FRESHWATER OCCURRENCE IN A TIDALLY DOMINATED SYSTEM.
San Jose State Univ., CA. Dept. of Geology.
J. A. Oberdorfer, P. J. Hogan, and R. W. Buddemeier.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 327-340, December 1990. 8 fig, 2 tab, 13 ref. DOE Contract W-7405-Eng-48.

Descriptors: *Atolls, *Geohydrology, *Groundwater movement, *Hydrologic models, *Islands, *Mathematical models, *Saline-freshwater interfaces, *Solute transport, Aquifers, Computer programs, Enjebi Island, Groundwater, Hydraulic conductivity, Reefs, Salinity, Sensitivity analysis, Tidal effects.

A layered-aquifer model of groundwater occurrence in an atoll island was tested with a solute transport numerical model. The computer model used, SUTRA, incorporates density-dependent flow. This can be significant in freshwater-saltwater interactions associated with the freshwater lens of an atoll island. Boundary conditions for the model included ocean and lagoon tidal variations. The model was calibrated to field data from Enjebi Island, Enewetak Atoll, and tested for sensitivity to a variety of parameters. This resulted in a hydraulic conductivity of 10 m/day for the surficial aquifer and 1000 m/day for the deeper aquifer; this combination of values gave an excellent reproduction of the tidal response data from test wells. The average salinity distribution was closely reproduced using a dispersivity of 0.02 m. The computer simulation quantitatively supports the layered-aquifer model, including under conditions of density-dependent flow, and shows that tidal variations are the predominant driving force for flow beneath the island. The oscillating, vertical flow produced by the tidal variations creates an extensive mixing zone of brackish water. The layered-aquifer model with tidally driven flow is a significant improvement over the Ghyben-Herzberg-Dupuit model as it is conventionally applied to groundwater studies for many Pacific reef islands. (Author's abstract)
W91-05446

REGIONAL MODELLING OF GROUNDWATER FLOW AND SALT AND ENVIRONMENTAL TRACER TRANSPORT IN DEEP AQUIFERS IN THE PARIS BASIN.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
H. F. Wei, E. Ledoux, and G. De Marsily.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 341-358, December 1990. 6 fig, 1 tab, 29 ref.

Descriptors: *Aquifers, *Aquitards, *Geohydrology, *Groundwater movement, *Salinity, *Solute transport, *Tracers, Carbon radioisotopes, Dogger Aquifer, Environmental tracers, Flow velocity, Helium radioisotopes, Hydrologic models, Mathematical models, Paris, Radioactive tracers, Transmissivity.

A hydrodynamic model was developed for the Dogger and adjacent aquifers in the Paris Basin. The challenges in building this model was the very limited information on these deep aquifers. With the help of this model, and explanation has been developed for the salinity distribution, the helium concentration distribution, and with the available data, the distribution of the residual 14-C activity. Although none of the available measurements (transmissivity, head, salinity and environmental tracers) is significant or certain enough to validate the model, the fact that the model accounts for all of them seems to provide some confidence in its representativity, although the uniqueness of the fitting cannot strictly be processed. An average Darcy velocity of 0.33 m/yr was calculated for the area south of Paris. This value is much lower than the velocities obtained with artificial tracers in geothermal wells using the single well dilution technique (15 m/yr). However, a recent study shows that these velocities may have been overestimated because of the possible existence of a vertical flow component in the well during these dilution measurements, owing to a vertical hydraulic gradient between different permeable layers in the formation. Alternatively, these high velocities although obtained in three different wells, one in Fontainebleau and two in Cachan, may be representative of only local anomalies, and not average large-scale behavior. (Geiger-PTT)
W91-05447

ECOHYDROLOGICAL PARAMETERS INDICATING DIFFERENT TYPES OF SHALLOW GROUNDWATER.
Amsterdam Univ. (Netherlands). Landscape and Environmental Research Group.
B. Pedroli.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 381-404, December 1990. 5 fig, 5 tab, 72 ref.

Descriptors: *Ecology, *Groundwater chemistry, *Physicochemical properties, *Soil-water-plant relationships, *Water chemistry, *Water quality, Conductivity, Geochemistry, Groundwater quality, Hydrogen ion concentration, Ions, Statistical analysis, The Netherlands.

Ecohydrology was used to evaluate a test data set of 412 analyses of groundwater samples from 60 locations in a Dutch coversand area, numerically classified into 17 water types. Three types of simple groundwater quality classifications were identified: single parameter, combined parameter and multiparameter. Single parameters like pH, electrical conductivity (EC) and ion concentration values give unsatisfactory representation of the complex conditional relationships between groundwater and the living part of the ecosystem. It was difficult to differentiate groundwater types reliably on the basis of one single parameter. Combined quality parameters such as a pH-EC plot, a plot of pHCO3 vs. (pH-pCa), and an ionic ratio (IR)-EC plot where the IR is a Ca/(Ca + Cl) ratio were widely used. The plot of pHCO3 vs. (pH-pCa) and the IR-EC plot indicate the residence time of the groundwater sampled as well as the hydrochemical conditions related to vegetation distribution and development. The IR is very popular for discriminating between atmocline (precipitation-like) and lithocline (long-residence groundwater-like) water types. In the test data set, objections to use of the

IR include a narrow theoretical basis in the intermediate IR range which should indicate potentially marked ecologic gradients. However, general relationships can be deduced from the IR-EC plot. In the test data set as well as in the general Dutch setting, the transformation of atmocline into lithocline water types determines to a large extent ecosystem diversity, although a third, metacline, pollution-induced water type increasingly interferes. Multiparameter classification of groundwater types include statistical classification according to statistical resemblance to defined reference groundwater samples. Statistical classification gives good results but is site specific. It was recommended that efforts be combined in the search for an internationally applicable composite classification adapted to ecohydrological research. (Author's abstract)
W91-05449

SOIL CONTROLS ON RECHARGE TO AQUIFERS.
Institute of Hydrology, Wallingford (England).
J. D. Cooper, M. K. Gardner, and N. Mackenzie.
Journal of Soil Science JSSCAH, Vol. 41, No. 4, p 613-630, December 1990. 10 fig, 2 tab, 35 ref. UK Dept. of Environment Contracts DGR480/276 and PECD 7/7/034.

Descriptors: *Aquifers, *England, *Groundwater recharge, *Soil properties, *Soil water, Discharge rates, Drainage, Evaporation, Hydraulic conductivity, Hydrologic budget, Rainfall, Temporal distribution.

The use of soil water measurements makes possible the determination of the pathways, timing and quantities of natural recharge to groundwater at sites on the Chalk and Triassic Sandstone aquifers in England. Water content and potential have been monitored for several years at seven sites and unsaturated hydraulic conductivity measured in situ at three of the chalk sites. Recharge was estimated using a combination of the zero flux plane method and a simple water balance. A shallow (approximately 1 m) depth of permeable drift and soil increased the annual drainage from the soil to the underlying formation by about 34% at a pair of sites on the Chalk aquifer. Effects upon drainage timing are equally dramatic. On thin soil directly on chalk, drainage responds quickly to rainfall and, once evaporation starts to exceed rainfall, declines rapidly. On drift-covered sites, the drainage continues for a much longer period. The drainage continues for a longer period from the loamy soil overlying the sandstone site. (Author's abstract)
W91-05469

HYDRAULIC CONDUCTIVITY AND LEACHING OF AN ORGANIC SALINE-SODIC SOIL.
Agricultural Coll. of Athens (Greece). Lab. of Soils and Agricultural Chemistry.
For primary bibliographic entry see Field 2G.
W91-05565

GROUNDWATER DILUTION AND RESIDENCE TIMES, AND CONSTRAINTS ON CHLORIDE SOURCE, IN THE MOKAI GEOTHERMAL SYSTEM, NEW ZEALAND, FROM CHEMICAL, STABLE ISOTOPE, TRITIUM, AND 36-CL DATA.
Geological Survey of Japan, Tsukuba. Mineral Resources Dept.
J. W. Hedenquist, F. Goff, F. M. Phillips, D. Elmore, and M. K. Stewart.
Journal of Geophysical Research (B) JJGBDU, Vol. 95, No. 12, p 19365-19375, November 10, 1990. 9 fig, 2 tab, 33 ref.

Descriptors: *Chlorides, *Geochemistry, *Geothermal studies, *Groundwater, *New Zealand, Chlorine radioisotopes, Fluid flow, Groundwater chemistry, Magmatic water, Mass spectrometry, Tracers, Tritium, Volcanoes, Water analysis.

Geochemical studies of the Mokai geothermal system, New Zealand, have identified a simple pattern of lateral fluid flow. Because fluid flow and groundwater dilution in the upper 1-2 km is simple and well understood, Mokai was chosen to test the application of radiogenic 36-Cl as a tracer of the chloride source(s) in the system and the patterns of groundwater circulation. Tandem accelerator mass spectrometry allowed the use of 36-Cl, which was previously restricted due to low natural abundance. Results indicate the deep thermal fluid rises in the south, inside the Maroa caldera margin, and flows to the north toward the Waikato River. As the thermal fluids flow laterally, they are progressively diluted with cold groundwater. The deep chloride component accounts for about half of the thermal flow at 4 km from the upflow, only 15% at 8 km north of the upflow, and less than 5% at about 12 km north of the upflow zone. The few thermal features over the top of the upflow originate primarily by steam heating. These characteristics were recognized early in the study, largely on the basis of the chemical tracers. Despite the overall simplicity of progressive groundwater dilution of the geothermal fluid with distance from the upflow, the 36-Cl and tritium data indicate a complicated circulation of groundwater of various residence times at the margins of the geothermal system. The results also indicate that the chloride was not derived from the host rock leaching in the upper 3 km; rather, the fluids have interacted with more primitive rocks below the drilled depths of the Taupo Volcanic Zone, with the chloride possibly derived from a magmatic brine. (Agostine-PTT)
W91-05570

TROPICAL HYDROLOGY AND CARIBBEAN WATER RESOURCES.
For primary bibliographic entry see Field 2A.
W91-05611

GROUND-WATER MANAGEMENT PROBLEMS IN THE NORTH CENTRAL COAST OF PUERTO RICO.
Puerto Rico Dept. of Natural Resources, San Juan.
For primary bibliographic entry see Field 4B.
W91-05614

SIGNIFICANCE OF CHEMICAL BOUNDARIES TO GROUND-WATER MANAGEMENT OF COASTAL AQUIFERS.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 4B.
W91-05615

DEVELOPMENT OF AN AQUIFER MANAGEMENT MODEL: AQMAN3D.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W91-05616

STUDY AND APPLICATION OF RAINFALL-RUNOFF MODEL FOR KARST REGIONS.
Nanjing Hydrological Research Inst. (China).
For primary bibliographic entry see Field 2A.
W91-05623

PROBLEMS OF GROUND-WATER DEVELOPMENT IN SMALL VOLCANIC ISLANDS IN THE EASTERN CARIBBEAN.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
N. S. Robins, A. R. Lawrence, and A. C. Cripps.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 257-267, 2 fig, 2 tab, 10 ref.

Descriptors: *Caribbean Sea, *Geohydrology, *Groundwater resources, *Island hydrology, *Islands, *Tropical hydrology, *Volcanic islands, *Water resources development, Aquifers, Groundwater budget, Groundwater movement, Hydraulic properties, Permeability, Rainfall, Volcanoes.

Young volcanic rocks offer the most favorable hydraulic properties for groundwater storage and flow, notably in the pyroclastic and reworked deposits. Three island types are recognized and illustrated by examples: (1) islands where abundant upland rainfall, coinciding with widespread Pleistocene and younger pyroclastics ensures high water tables even at high elevations, (2) islands with moderate rainfall and with Pleistocene deposits which drain rapidly to the coast; and (3) islands with early Tertiary volcanic rocks of low permeability, but which may yield water from shallow weathered zones in selected areas. In general, pyroclastic rocks dominate the younger volcanic suites. The distal volcanic deposits are potentially the best aquifers. However, weathering reduces their permeability and that of the pyroclastics. The older deposits, which are usually the more weathered, are typically of low permeability. (See also W91-05611) (Lantz-PTT)
W91-05637

GROUND-WATER SUPPLY STUDY FOR THE NIGUA RIVER BASIN IN THE DOMINICAN REPUBLIC.
Camp, Dresser and McKee, Inc., Atlanta, GA.
M. D. Taylor, R. C. Johnson, and J. Brea.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 269-278, 7 fig, 3 ref.

Descriptors: *Dominican Republic, *Groundwater resources, *Nigua River Basin, *Tropical hydrology, *Water resources development, *Water supply, Aquifer systems, Computer models, Groundwater basins, Groundwater budget, Groundwater management, Groundwater recharge, Surface-groundwater relations.

The Nigua River groundwater basin, near the southern coast of the Dominican Republic, is composed of alluvial deposits and covers an area of approximately 8 square miles, with an average thickness of 100 feet. An investigation was conducted into how to best develop the basin as a source of water, so that 8 million gallons/day will always be available. To help evaluate different well-field options, a 3 dimensional finite-element computer model was developed and used to simulate aquifer system response to different well field development schemes. An extensive field program was also conducted to help determine aquifer parameters used in the model. The results of the study indicate that the best approach to groundwater development, consists of two steps: (1) initially use wells close to the Nigua River as the primary water supply when there is enough flow in the river to provide 8 million gallons/day of recharge, and (2) then use wells tapping the groundwater reservoir as a supplementary water supply when flow in the river does not provide enough aquifer recharge to meet the 8 million gal/day requirement. During periods of high river flow, the river will recharge the groundwater reservoir, which can then be tapped when river flow is low. (See also W91-05611) (Lantz-PTT)
W91-05638

GROUND-WATER POLLUTION RISK ASSESSMENT FOR PUBLIC WATER SUPPLY SOURCES IN BARBADOS.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
P. J. Chilton, A. A. Vlugman, and S. S. D. Foster.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 279-289, 4 fig, 2 tab, 4 ref.

Descriptors: *Barbados, *Groundwater pollution, *Risk analysis, *Tropical hydrology, *Water pollution sources, *Water sources, *Water supply, Agricultural runoff, Environmental protection, Groundwater quality, Industrial development,

Monitoring, Pesticides, Urbanization, Water quality control, Water resources development.

Barbados is almost totally dependent on groundwater for its public water supplies, and the island has a long history of groundwater exploitation. A detailed pollution risk assessment has been carried out in a catchment which provides 60% of the public water supply of Barbados. Comprehensive surveys of agricultural land use, residential sanitation, and industrial activities were undertaken. These allowed an appraisal of the susceptibility to nutrient and pesticide leaching from cultivated land to be made, together with estimates of subsurface contaminant load from sanitation, and identification of risks from industrial and commercial activities. A complimentary program of groundwater quality monitoring has been established. The results of the study indicate that there are potential risks of groundwater pollution from changing agricultural practices, from urbanization and from industrial development, but the long established development control zone policy has served Barbados relatively well in protecting its groundwater resources to date. (See also W91-05611) (Author's abstract)
W91-05639

TECHNIQUES FOR APPRAISAL OF GROUND-WATER RESOURCES ON ATOLL ISLANDS: CASE STUDIES FROM MICRONESIA.
Geological Survey, Honolulu, HI. Water Resources Div.
S. J. Anthony.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 291-300, 3 fig, 1 tab, 20 ref.

Descriptors: *Atolls, *Groundwater resources, *Island hydrology, *Islands, *Micronesia, *Surveys, *Tropical hydrology, Caroline Islands, Case studies, Data acquisition, Groundwater budget, Marshall Islands, Monitoring, Monitoring wells.

The U S Geological Survey, since 1983, has done groundwater resource appraisals on Majuro, Mwoakilloa, Pingelap, and Ulithi atolls of the Marshall and Caroline islands. The information gained from these studies has been used to develop and modify a general conceptual geohydrologic framework model for atoll islands, define the thickness and areal extent of the fresh-water lenses, determine the response of fresh-water lenses to climatic stress, and estimate groundwater recharge rates and safe yields. Groundwater recharge and safe yield can be estimated as a first-order approximation by an annual water budget under average regional climatic conditions and assuming that withdrawal of groundwater is equivalent to reducing vertical recharge, respectively. Transportation constraints often prevent the collection of subsurface geologic data; therefore, subsurface layering has to be inferred from indirect measurements such as groundwater tidal response and slug test data, and compared with the conceptual geohydrologic model. Groundwater tidal response data from Mwoakilla, Pingelap, and Ulithi appear to be controlled by subsurface layering within the Holocene deposits, and not the permeability contrast between Holocene and Pleistocene deposits as was observed at Majuro. (See also W91-05611) (Lantz-PTT)
W91-05640

GEOPHYSICAL MAPPING AND HYDROGEOLOGIC ANALYSIS OF FRESH-WATER LENSES AT BIG PINE KEY, FLORIDA.
University of South Florida, Tampa. Dept. of Geology.
M. J. Wightman, M. T. Stewart, and H. L. Vacher.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 301-309, 5 fig, 15 ref.

Descriptors: *Big Pine Key, *Florida, *Freshwater lenses, *Geohydrology, *Geophysical surveys, *Geophysics, *Mapping, *Saline-freshwater interfaces, *Tropical hydrology, Case studies, Electromagnetic waves, Hydraulic conductivity, Hydrologic maps, Seasonal variation, Surveys.

A case study provides detailed mapping of the salt/fresh water interface throughout Big Pine Key. Contour maps of the depth to interface show the lateral and vertical extent of the two freshwater lenses in this carbonate island during both the wet and dry seasons. The maximum depth of the freshwater lenses is strongly controlled by the vertical distribution of hydraulic conductivity as shown by the comparison of the maps of the interface with the published core data. The control is similar to that at several larger Bahamian islands where the interface is strongly refracted as it enters a buried limestone with a larger hydraulic conductivity. At Big Pine Key, the geologic control is the contact between the surficial Miami oolite and the underlying Key Largo biolithite. The hydraulic conductivity of the two geologic units (K1 and K2) was estimated from comparison of the mapped geometry of the interface with the type curves developed from analytical Dupuit-Ghyben-Herzberg models of lenses in layered islands, using an independent estimate of recharge (R). The results suggest that R = 0.2 to 0.3 meters/yr, K1 = 100 to 140 meters/day, and K2/K1 = 10 to 15 in this island. The technique is applicable to many other small islands composed of Quaternary limestones. (See also W91-05611) (Lantz-PTT)
W91-05641

VERY LOW FREQUENCY ELECTROMAGNETIC MAPPING OF A FRESHWATER LENS AT KEY WEST, FLORIDA.
Environmental Resources Management-South, Inc., Miami, FL.
J. L. Labowski, D. J. McKenzie, and A. L. Higer.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 311-316, 3 fig, 9 ref.

Descriptors: *Florida, *Freshwater lenses, *Key West, *Mapping, *Saline-freshwater interfaces, *Tropical hydrology, Data interpretation, Electromagnetic waves, Geophysics, Groundwater budget, Groundwater resources, Hydrologic maps, Monitoring wells, Salinity, Tidal effects.

The amount of fresh groundwater beneath Key West, Florida, was evaluated using a very low frequency (VLF) survey. The survey was conducted to help define the general configuration of the freshwater lens (250 mg/L Cl concentration or less), which constantly changes due to tidal effects. The VLF survey, unlike other geophysical techniques, is insensitive to electrical interferences, and thus, feasible for highly urbanized Key West. Wells were constructed and water column profiles of specific conductance and chloride made to further define the lens shape, transition zone (freshwater-saltwater mix), and saltwater interface. The zones of freshwater and salinity, defined by the ohm-meter contours and the chloride contours, where in general agreement. Readings of 10 ohm-meters generally correspond to chlorides of 250 to 500 milligrams/L, representing relatively freshwater. The highest reading (13.5 ohm-meters) was obtained near a former freshwater spring. The freshwater lens was thickest, averaging about 5 feet, near the center of western Key West (Old Town). The freshwater volume was about 20 million gallons at the end of the dry season. The depth to the saltwater interface under the center of the island was about 40 ft. (See also W91-05611) (Author's abstract)
W91-05642

SHAPE OF FRESHWATER LENS IN SMALL CARBONATE ISLANDS: GREAT EXUMA VS. BERMUDA AND THE EFFECT OF CLIMATE.
University of South Florida, Tampa. Dept. of Geology.
T. N. Wallis, and H. L. Vacher.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 317-326, 4 fig, 27 ref. NSF Grant INT-8814493.

Descriptors: *Aquifer characteristics, *Bahamas, *Bermuda, *Carbonate rocks, *Climatology, *Freshwater lenses, *Geohydrology, *Great Exuma Island, *Groundwater resources, *Islands, *Saline-freshwater interfaces, *Tropical hydrology, Evapotranspiration, Groundwater budget, Groundwater recharge, Hydrologic models, Marshes, Model studies, Rainfall, Salinity, Wetlands.

A comparison between the geohydrology of Bermuda and Great Exuma, Bahamas, illustrates the control of climate on the location and geometry of freshwater lenses in small islands composed of Quaternary coastal eolianites. The eolianites of the islands formed mainly when sea level was below its present position, so some inter-eolianite topographic lows became submerged with the Holocene sea-level rise. The lows now form marshes and ponds. Climate determines whether these inland water bodies are recharge or discharge areas. On Great Exuma Island, annual potential evapotranspiration exceeds rainfall. The inland ponds are brackish to hypersaline, and the freshwater lenses are localized beneath the eolianite ridges that occur between the ponds. In Bermuda, where annual potential evapotranspiration does not exceed rainfall, ponds and marshes that lie in the interior of the island are typically fresh; the occurrence of fresh groundwater is controlled by the geology of the saturated zone rather than the island's topography. The Dupuit-Ghyben-Herzberg model, suggests that the effect of the evaporation excess at the ponds is a thinning of the lens by as much as some 30 to 40 meters relative to the same island with uniform recharge. (See also W91-05611) (Author's abstract)
W91-05643

HYDROGEOLOGY AND TIDAL ANALYSIS ALONG THE WESTERN NORTH COAST OF THE YUCATAN PENINSULA, MEXICO.
ATEC Associates, Inc., Griffith, IN.
A. Reeve, and E. C. Perry.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 327-337, 6 fig, 1 tab, 19 ref. NSF Grant Ear-8508173.

Descriptors: *Geohydrology, *Karst hydrology, *Mexico, *Saline-freshwater interfaces, *Surface-groundwater relations, *Tidal effects, *Tropical hydrology, *Yucatan Peninsula, Aquifers, Confined aquifers, Geochemistry, Groundwater budget, Groundwater recharge, Mixing, Saline water intrusion.

An impermeable surface layer along the western north coast of the Yucatan Peninsula confines groundwater near the coast and increases the hydraulic head in the highly permeable Yucatan Aquifer. An extensive saltwater wedge that penetrates far inland underlies the fresh groundwater lens, and the thickness of this lens is increased by the coastal aquitard. Present construction activities in this coastal area may destroy the surface aquitard resulting in a decrease in the hydraulic head. This would reduce the thickness of the freshwater lens and diminish freshwater resources near the coast. Large, tidally induced, groundwater fluctuations have been observed up to five kilometers inland in the study area. The damping effect of tidal impulses is used in this paper to calculate aquifer dispersivity and estimate other parameters. Samples of groundwater were obtained from the freshwater lens and analyzed for major cations and

alkalinity. These measurements indicate that the major geochemical processes occurring in the aquifer are mixing of fresh and seawater and carbonate dissolution. High concentrations of salts present in these samples indicate that extensive mixing is occurring between the fresh and saline groundwater bodies. (See also W91-05611) (Author's abstract)
W91-05644

APPLICATION OF THE BOUNDARY ELEMENT METHOD TO SOME PROBLEMS IN WATER RESOURCES.
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
R. Srivastava, and D. N. Contractor.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 339-348, 4 fig, 17 ref.

Descriptors: *Boundary element method, *Boundary processes, *Computer programs, *Groundwater movement, *Model studies, *Multiphase flow, *Saline water intrusion, *Tropical hydrology, Data interpretation, Finite element method, Groundwater recharge, Guam, Mathematical equations, Mathematical studies, Porous media.

A computer code has been developed to solve the two-dimensional (vertical section) problem of transient, multi-phase flow through porous media using the boundary element method. The governing equations in each phase are solved simultaneously for the potential head in each phase. Along the sharp interface between the phases, the pressure in both phases are made equal and the continuity of mass is maintained. The numerical analysis of the boundary element equations results in a full matrix. Iterations within a time-step are avoided by computing the matrix coefficients using the conditions at the previous time and using a small time-step. The code is applied to three different problems in water resources. The first application is the transient flow through an earth dam due to a rising upstream reservoir level. The results of this program compare favorably with the results from previous studies. The second application studies the transient movement of the fresh saltwater interface in a coastal aquifer subject to a constant freshwater recharge through a strip of the aquifer. An analytic solution to this problem is available, as well as numerical solutions using finite-element and boundary-element methods. These results are compared with the results of this program for different values of alpha in the coastal boundary condition. The final application was to the problem of saltwater intrusion into the island of Guam. These applications indicate that the boundary element method can be a powerful tool in the solution of complex water resource problems. (See also W91-05611) (Author's abstract)
W91-05645

LABORATORY SIMULATION OF THE EFFECTS OF OVERBURDEN STRESS ON THE SPECIFIC STORAGE OF SHALLOW ARTESIAN AQUIFERS.
Geological Survey, San Juan, PR. Water Resources Div.
N. Sepulveda, and A. L. Zack.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 349-356, 3 fig, 1 tab, 15 ref.

Descriptors: *Confined aquifers, *Model studies, *Overburden, *Simulation analysis, *Specific yield, *Stress, *Tropical hydrology, Aquifers, Groundwater budget, Hydrostatic pressure, Interstitial water, Mathematical analysis, Mathematical studies, Pore pressure.

A laboratory experiment to measure the specific storage of an aquifer material was conducted. A known dead load, simulating an overburden load, was applied to a sample of completely saturated aquifer material contained inside a cylinder. After the dead load was applied, water was withdrawn from the sample, causing the hydrostatic pressure to decrease and the effective stress to increase. The resulting compression of the sample and the amount of water withdrawn were measured after equilibrium was reached. The procedure was repeated by increasing the dead load and the hydrostatic pressure followed by withdrawing water to determine new values of effective stress and compaction. The simulated dead loads are typical of those experienced by shallow artesian aquifers. The void ratio and the effective stress of the aquifer sample, as simulated by different dead loads, determine the pore volume compressibility which, in turn, determines the values of specific storage. An analytical algorithm was used to independently determine the stress dependent profile of specific storage. These values are found to be in close agreement with laboratory results. Implications for shallow artesian aquifers, with relatively small overburden stress, are also addressed. (See also W91-05611) (Author's abstract)
W91-05646

ASPECTS OF THE HYDROGEOLOGY OF THE NORTHWEST REGION, YUCATAN PENINSULA, MEXICO.
Northern Illinois Univ., De Kalb. Dept. of Geology.
E. C. Perry.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 357-365, 3 fig, 23 ref. NSF Grant No. Ear-8508173.

Descriptors: *Aquifer characteristics, *Confined aquifers, *Geohydrology, *Groundwater quality, *Karst hydrology, *Mexico, *Path of pollutants, *Saline-freshwater interfaces, *Tropical hydrology, *Yucatan Peninsula, Aquifers, Bacteria, Coastal aquifers, Dolomite, Heavy metals, Interstitial water, Nitrates, Tidal effects.

From the earliest Spanish exploration of the Yucatan, the geohydrology of the north coast, characterized by dune ridges backed by a saline swamp, has influenced human activity. This special geohydrologic environment appears to be a consequence of precipitation of calcite by evaporating CO2 saturated groundwater in pores of surface water near the coast. The result is a thin, almost impermeable caliche-like crust that impedes the flow of groundwater to the ocean. The coastal confining layer isolates the freshwater lens and increases its thickness. Furthermore, it reduces the damping of tides within the coastal portion of the Yucatan aquifer. Tidal oscillations within the aquifer may enhance the mixing of fresh and salt water at the base of the freshwater lens to produce a long, narrow zone that is a likely site of extensive carbonate diagenesis. In the northeast Yucatan, a semicircular permeable zone of about 80 kilometers radius, centered approximately on Merida selectively captures groundwater and delivers it to the coast. A submerged Yucatan cave, Noc-Ac Cenote, is the site of modern deposition of dolomite. This relatively accessible site may provide a rare opportunity to observe and record the environment of dolomitization. This dolomite occurrence is near the top of a dynamic zone of mixing of fresh and salt water at the base of the peninsular freshwater lens. Pollution of the Yucatan aquifer is an ancient problem that is increasing in amount and diversity with the development of industry and an export agriculture. Bacteria and nitrates are traditional aquifer pollutants. Toxic organic compounds and heavy metals from industrial development are likely modern contributors from industrial development unless special care is taken to protect the aquifer. (See also W91-05611) (Author's abstract)
W91-05647

GROUND WATER SEEPAGE IN THE INDIAN RIVER LAGOON, FLORIDA.
Florida Inst. of Tech., Melbourne. Dept. of Chemical and Environmental Engineering.
T. V. Belanger, and R. B. Walker.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 367-375, 5 fig, 2 tab, 24 ref.

Descriptors: *Aquifer characteristics, *Coastal aquifers, *Florida, *Groundwater movement, *Indian River Lagoon, *Seepage, *Surface-groundwater relations, *Tropical hydrology, Finite difference methods, Finite element method, Indian River, Lagoons, Model studies, Tidal effects.

Groundwater seepage meters were installed across a transect of Indian River Lagoon near Jensen Beach, Florida, and were sampled from July 1988 through March 1989. Unlike most lake seepage patterns, seepage rates increased with increasing distance from shore and depth. Tidal fluctuations exhibited a strong impact on near-shore (<150 meters) seepage rates but had no affect on rates further from shore. The measurements indicated the existence of several areas of very high seepage (>0.48 m/d), and it is thought these areas represent locations where discontinuities in the underlying clay layer exist. Precision, determined from duplicate meters located within a few centimeters of each other, was very good. The average measured seepage rate (0.12 m/d) was considered higher than previous estimates (0.00076 to 0.0026 m/d) for this transect using a Galerkin finite-element model. The data indicate the modeling results may be in error due to inaccurate model input data and boundary conditions, pointing out the complexity of the task and the need for more direct measurement studies. Currently, seepage estimates are being made at the transect with the USGS finite difference 3-D model (Modflow) using precisely determined input data (head boundaries, hydraulic conductivity, etc.) for comparison with seepage meter data. (See also W91-05611) (Author's abstract)
W91-05648

APPLICATION OF GROUND-WATER ARTIFICIAL RECHARGE IN A BRACKISH/SALT-WATER ENVIRONMENT.
CH2M Hill, Deerfield Beach, FL.
A. Muniz, S. Skehan, and P. J. Kwiatkowski.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 377-386, 6 fig, 1 tab, 2 ref.

Descriptors: *Artificial recharge, *Brackish water, *Groundwater recharge, *Groundwater storage, *Saline-freshwater interfaces, *Tropical hydrology, *Water supply, Aquifers, Florida Keys, Hydrologic models, Mathematical models, Water resources development, Wells.

The Aquifer Storage Recovery (ASR) concept was investigated as a potential means of storing fresh water to meet the emergency needs of the Florida Keys Aqueduct Authority. Preliminary evaluation of ASR at Marathon, Florida, identified a potential storage zone between depths of 410 and 435 feet. Numerical modeling was conducted and confirmed the feasibility of using ASR in a saline aquifer. A 16 inch diameter ASR well was constructed and screened within the storage zone. Two observation wells were completed in this same zone so that aquifer characteristics could be determined from a 24-hour pumping test. Results of this test indicate the storage zone is moderately permeable, a desirable criterion for ASR. Cycle testing should provide the final data necessary to evaluate full-scale implementation of ASR in the Florida Keys. (See also W91-05611) (Lantz-PTT)
W91-05649

ARTIFICIAL GROUND-WATER RECHARGE, VENTURA COUNTY, CALIFORNIA.
Banner Associates, Inc., Grand Junction, CO.
For primary bibliographic entry see Field 4B.
W91-05650

INTERACTIVE COMPUTER PROGRAM MODUMANAG, A DATA MANAGEMENT TOOL FOR THE MODULAR FINITE-DIFFERENCE GROUND-WATER FLOW MODEL.
Geological Survey, San Juan, PR. Water Resources Div.
S. Torres-Gonzalez, and L. I. Rolon-Collazo.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 403-410, 7 fig, 2 tab, 1 ref.

Descriptors: *Computer programs, *Data processing, *Finite difference methods, *Flow models, *Groundwater movement, *MODUMANG program, *Tropical hydrology, Computer models, Data interpretation, Groundwater management, Hydrologic maps, Maps, Model studies.

A data management program was developed for pre-processing and post-processing of input and output data for the USGS's Modular groundwater flow model. The menu-driven program performs data computations for model input and edits, plots, and summarizes model output. The subroutines that perform the different tasks are called options and work independently. They can be used to compute two dimensional arrays of hydrologic and hydraulic parameters based on existing arrays. The options can also be used to edit data at specific model cells or a group of cells within a data array. The program can plot an output data array as a contour map or a 3-D surface. MODUMANAG also may be used to generate a two-dimensional data array from a digitized contour map and to summarize model results in graphical or tabular form. The program was written in FORTRAN 77 for the Prime series 50 minicomputer. (See also W91-05611) (Author's abstract)
W91-05652

CHEMICAL AND STABLE ISOTOPIC CHARACTERISTICS OF GROUND WATER ON GRAND CAYMAN.
Alberta Univ., Edmonton. Dept. of Geology.
K. C. Ng, and B. Jones.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 411-420, 4 fig, 32 ref. Natural Science and Engineering Research Council of Canada Grant No. A6090.

Descriptors: *Freshwater lenses, *Geochemistry, *Grand Cayman Island, *Groundwater quality, *Isotope studies, *Karst hydrology, *Tropical hydrology, *Water chemistry, Groundwater recharge, Islands, Rainfall, Saline-freshwater interfaces, Sulfates, Water quality.

In carbonate terrains where water-rock interactions are significant, useful information concerning the groundwater origin, recharge phenomenon, and flow regime can be obtained from detailed investigations of the chemical and stable isotopic contents of the groundwater. Hydrochemical and stable isotopic data on Grand Cayman indicate that rainwater recharge occurs predominantly during periods of heavy rain. Rainfall of low intensity is insignificant. Systematic analysis of the groundwater on Grand Cayman shows that its chemical constituents are derived from: (1) salts from rainwater which are subsequently concentrated by evaporation, (2) an influx of calcium enriched groundwater from the surrounding limestone aquifers, (3) a periodic influx of water trapped in sinkholes, (4) dissolution of carbonate minerals, (5) precipitation of carbonate minerals (6) sulfate reduction in a reducing environment, and (7) salts derived from underlying saline water. The major freshwater lenses of Grand Cayman, developed in dolostones of the Oligocene-Miocene Bluff Formation, show distinct spatial and temporal variation in hydrochemical and stable isotopic composition. The amount of variation is related to the degree of external influences and water-rock interactions. Subenvironments developed in the unconfined aquifers, controlled by jointing and karsting, also lead to variation in groundwater properties. (See also W91-05611) (Author's abstract)
W91-05653

WATER QUALITY OF A CARBONATE ISLAND KARST AQUIFER, SAN SALVADOR ISLAND, BAHAMAS.
Mississippi State Univ., Mississippi State. Dept. of Geology and Geography.
W. Balcerzak, J. Mylroie, and G. S. Pabst.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 421-431, 2 fig, 5 tab, 14 ref.

Descriptors: *Bahamas, *Carbonate rocks, *Groundwater pollution, *Groundwater quality, *Karst hydrology, *San Salvador Island, *Tropical hydrology, *Water pollution sources, Aquifers, Coliforms, Dissolved oxygen, Dissolved solids, Geohydrology, Groundwater recharge, Hydrogen ion concentration, Rainfall, Water chemistry.

The water quality and distribution of groundwater on San Salvador is assessed. A total of 86 water samples were collected from 67 wells and catchments and a baseline study was conducted to establish various physical and microbial parameters. In situ measurements included conductivity, pH, dissolved oxygen, and temperature. Microbial analyses were made of total coliform, fecal coliform, and fecal streptococci. Average conductivity was found to be 2,270 microsiemens/cm, corresponding to a total dissolved solids (TDS) value of 1,470 mg/l. Delineation of some lenses appears to be possible by the similarity of physical parameters and the location of the aquifer in relation to lakes, shoreline, and topography. Microbial counts show very high fecal streptococci levels and little to no fecal and total coliforms, indicating recent animal contamination from an avian or ruminant animal source. In a few locations higher total coliform indicates occasional aquifer contamination by human waste. (See also W91-05611) (Lantz-PTT)
W91-05654

UTILIZATION OF INTRACELLULAR GRANULES OF INT-FORMAZAN AND GENE PROBES FOR TRACING MICROORGANISMS IN GROUND WATER.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
For primary bibliographic entry see Field 5B.
W91-05661

CENTER FOR AQUIFER SCIENCE AND TECHNOLOGY (CAST).
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 9C.
W91-05795

MULTIPHASE FLOW AND TRANSPORT IN POROUS MEDIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5B.
W91-05798

MAPPING ZONES OF CONTAMINATED GROUND-WATER DISCHARGE USING CREEK-BOTTOM-SEDIMENT VAPOR SAMPLERS, ABERDEEN PROVING GROUND, MARYLAND.
Geological Survey, Columbia, SC.
For primary bibliographic entry see Field 5B.
W91-05813

APPLICATIONS OF FORWARD MODELING RESISTIVITY PROFILES.
United Nations Educational, Scientific and Cultural Organization, Paris (France). Div. of Water Sciences.
F. Radstake, W. Geirnaert, T. W. Kleinendorst, and J. C. Terhell.
Ground Water GRWAAP, Vol. 29, No. 1, p 13-17, January/February 1991. 9 fig, 13 ref.

Descriptors: *Borehole geophysics, *Computer models, *Data acquisition, *Geohydrology, *Model studies, *Resistivity profiles, *Resistivity surveys, Burkina Faso, Geoelectrical prospecting, Geologic formations, Geophysics, Granites, Schists, Schlumberger array, Spatial distribution, Wenner array.

The Schlumberger array offers better resolution than the Wenner array and therefore often is used in detailed studies of borehole siting. For regional studies, however, the Wenner array offers certain advantages: better signal-to-noise ratio and smoother curves. A simple two-dimensional interpretation model for resistivity profiles and soundings, similar to the one presented recently by Mufti, has been developed for a personal computer (IBM-compatible). With the aid of the computer program, a synthetic response of Wenner and Schlumberger soundings or profiles can be generated for two-dimensional subsurface structures. The possibility of calculating a resistivity response in advance offers a tool to optimize electrode configurations and spacings, and hence greatly improves the value of the measurements. A better insight also is obtained into how geological structures may affect the size and shape of anomalies in resistivity profiles. With the aid of the model, the sensitivity of Schlumberger and Wenner arrays to the weathered layer thickness in a granitic environment is illustrated, and a case study of the quantitative interpretation for a resistivity profile from a schistose environment in Burkina Faso is presented. Although the forward modeling in itself is not unique, the optimal electrode spacing can be determined in advance and a better insight obtained into the sensitivity of geoelectrical prospecting for various geologic structures. Selection of the best location for drilling may be facilitated by comparing model results with field data. (Rochester-PTT)
W91-05814

ONE-DIMENSIONAL TRACER MODEL.
H. Huang.
Ground Water GRWAAP, Vol. 29, No. 1, p 18-20, January/February 1991. 2 fig, 3 ref.

Descriptors: *Groundwater movement, *Mathematical analysis, *Tracers, Adsorption, Breakthrough curves, Decomposition, Dispersion, Flow velocity, Model studies.

One of the main objectives for tracer investigation of groundwater flow is to estimate the average interstitial velocity of the flow. Although empirical methods exist for employing the analytical solution of one-dimensional tracer models and the tracer breakthrough curve to calculate the average velocity, the accuracy of the empirical method is influenced by the dispersion degree of the tracer. A simpler method with greater accuracy would be desirable. From the analytical solution to the instantaneous injection model, two sets of equations are given for calculating the three important parameters (V, average linear velocity; D, dispersion coefficient; and E, effective initial concentration) from two or three points on the tracer breakthrough curve. If two points are used, one of them must be the maximum concentration on the tracer breakthrough curve. The effective initial concentration (E) calculated from the tracer breakthrough curve must be less than the initial injection concentration (M/PS, where M is the mass being injected, P is the porosity of the reservoir, and S is the cross-sectional area of the flow for an injection). The difference between the initial injection concentration and the calculated effective initial con-

centration might be used to evaluate the degree of tracer loss resulting from the combined effect of multidirectional dispersion, adsorption, and/or decomposition. (Rochester-PTT)
W91-05815

MODELING SOLUTE TRANSPORT IN GROUND WATER AT OR NEAR FREEZING.
Alaska Univ., Fairbanks. Dept. of Mining and Geological Engineering.
For primary bibliographic entry see Field 5B.
W91-05816

ESTIMATING RECHARGE RATES THROUGH UNSATURATED GLACIAL TILL BY TRITIUM TRACING.
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
D. P. Daniels, S. J. Fritz, and D. I. Leap.
Ground Water GRWAAP, Vol. 29, No. 1, p 26-34, January/February 1991. 4 fig, 2 tab, 32 ref.

Descriptors: *Groundwater recharge, *Indiana, *Infiltration, *Isotope studies, *Recharge, *Tracers, *Tritium, Catchment areas, Cores, Groundwater movement, Hydrologic budget, Radioisotopes, Seasonal distribution, Till, White River.

Tritium produced by aboveground thermonuclear tests has been shown to be an excellent tracer for following the downward movement of water in both the unsaturated and saturated zones. A tritium profile obtained from a core located on the Tipton Till Plain near West Lafayette, Indiana, showed a 'tritium reversal' (corresponding to a low-high-low activity of tritium relative to depth) at 7 m, indicating the present position of recharge water derived from 1963/64 precipitation. The average recharge rate calculated using the tritium data is 3.5 cm/yr for the 'mass balance' method and 4.7 cm/yr for the 'transit-time' method. The average of 4.1 cm/yr is in reasonable agreement with Arihood's (1982) estimate of 5.1 cm/yr for tills, based on numerical modeling of data from a water-budget study in the White River basin of Indiana. Two other cores, located on a nearby topographically lower slope, showed no definite reversal in tritium activity, probably because of lateral flow components at these locations. To be applied, the tritium technique should assess the contribution of summer and winter precipitation to recharge because tritium activities tend to peak in spring and summer precipitation. Contrary to the usual assumptions that recharge to aquifers in temperate zones of the northern hemisphere occurs between October and April, stable isotopic data of well water in the study area indicate that an appreciable amount of annual recharge (about 34%) actually occurs between April and October. (Author's abstract)
W91-05817

SIMPLE DERIVATION OF THE RETARDATION EQUATION AND APPLICATION TO PREFERENTIAL FLOW AND MACRODISPERSION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer.
Ground Water GRWAAP, Vol. 29, No. 1, p 41-46, January/February 1991. 5 fig, 2 tab, 36 ref.

Descriptors: *Breakthrough curves, *Groundwater movement, *Path of pollutants, *Preferential flow, *Saturated flow, *Sorption, *Unsaturated flow, Aquifers, Macrodispersion, Mathematical equations, Performance evaluation, Retardation equation, Vadose zone.

The formula most often found in the literature for calculating the retardation factor of sorbing pollutants from the distribution coefficient and aquifer properties is for saturated flow. The equation is applicable to one-dimensional, horizontal, single-phase flow in saturated, unconsolidated, homogeneous porous media. A new equation to calculate the retardation factor for sorbing chemicals moving in aqueous solution through aquifers and vadose zones has been derived using a linear sorption isotherm and a simple mass-balance approach. The procedure is very simple and clearly illustrates the roles of the porosity (n) and the volumetric water content (theta), including those for saturated flow, unsaturated flow, and preferential flow or other systems with both mobile and immobile phases of the water. Applications of the equation to preferential flow in the vadose zone and macrodispersion in a layered aquifer are illustrated with numerical examples for hypothetical cases. Breakthrough curves for layered systems with different hydraulic conductivities, porosities, and retardation coefficient for each layer can be estimated simply by assuming a piston flow in each layer. This produces a step breakthrough curve, through which a smooth curve can be drawn. The resulting curve tends to be parabolic rather than sigmoid and, when determined in the field, can be used to estimate the average retardation factor of the more permeable formations of the aquifer. Preferential flow in vadose zones and aquifers also can increase the volume of clean water needed to reduce contaminant concentrations to acceptable levels. (Rochester-PTT)
W91-05819

AQUEOUS GEOCHEMISTRY OF THE SAND-AND-GRAVEL AQUIFER, NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL.
For primary bibliographic entry see Field 2K.
W91-05820

ASSESSMENT OF POROUS MEDIA HETEROGENEITY BY INVERSE PLUME ANALYSIS.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
For primary bibliographic entry see Field 5B.
W91-05821

PARTICLE TRACKING ANALYSIS OF RECHARGE AREAS ON LONG ISLAND, NEW YORK.
Geological Survey, Trenton, NJ.
For primary bibliographic entry see Field 5B.
W91-05822

GROUND-WATER DISCHARGE TO LAKES: FOCUSING IN EMBAYMENTS.
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
D. S. Cherkauer, and P. F. McKereghan.
Ground Water GRWAAP, Vol. 29, No. 1, p 72-80, January/February 1991. 9 fig, 3 tab, 20 ref. Federal Grant NA84AA-D-00065, Project R/MW-35.

Descriptors: *Aquifers, *Base flow, *Lake Michigan, *Michigan, *Simulation, *Surface-groundwater relations, *Wisconsin, Digital computers, Dolomite, Focusing, Green Bay, Hydraulic conductivity, Hydraulic gradient, Hydrologic models, Mathematical models.

Seepage of groundwater to Green Bay and Lake Michigan from a fractured dolomite aquifer beneath the Door Peninsula of Wisconsin was examined to determine the influences of embayments on the relative amounts of groundwater discharge. A digital simulation was used to calculate the quantity and distribution of that discharge. The simulation results are based on the net recharge that occurs on the land portion of the study area. They compare favorably with discharges calculated by flow net using observed hydraulic gradients and conductivities, and are in relative agreement with direct measurements made by seepage meters. The simulation has not been verified (due to lack of independent observations), but the similarity of the discharges from the three methods supports the model's validity. In the study area, 66,000 cu m/day of groundwater is discharged directly into Green Bay (26,000 cu m/day) and Lake Michigan (40,000 cu m/day). Almost 60% of this total occurs in 20 embayments along the shore, even though they occupy only about 33% of the shoreline length as measured parallel to the long axis of the peninsula. Discharge is focused into embayments by distortion of equipotential lines caused by a bay's penetration into the groundwater system. In the study area, it is shown that flow amplifications of up to 500% vary directly with two measures of the shoreline shape at bays, horizontal penetration (defined as the ratio of a bay's axial length to the distance to the groundwater divide), and vertical penetration (the ratio of maximum bay depth to aquifer thickness). Both factors have equal influence on the amplification of discharge. A graphical means of predicting the effect of coastal configurations on other bays was developed, but its applicability outside the study area is unknown. (Author's abstract)
W91-05823

GROUND-WATER CONTAMINATION FROM TWO SMALL SEPTIC SYSTEMS ON SAND AQUIFERS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 5B.
W91-05824

NUMERICAL SIMULATION OF SUBSURFACE-WATER RISE IN KUWAIT CITY.
Kuwait Inst. for Scientific Research, Safat.
L. Hamdan, and A. Mukhopadhyay.
Ground Water GRWAAP, Vol. 29, No. 1, p 93-104, January/February 1991. 12 fig, 5 tab, 8 ref.

Descriptors: *Kuwait, *Model studies, *Urbanization, *Water level, *Water table rise, Computer models, Flooding, Groundwater management, Groundwater recharge, Irrigation-return flow, Leaks, Selective withdrawal, Wastewater, Water table.

The residential areas of Kuwait City have been affected by a rise in the subsurface-water level in recent years, causing waterlogging and flooding of basements of buildings. To study this phenomenon, and to ascertain its causes, a numerical aquifer simulation model was developed. The aquifer model showed that, over the period 1961-1985, the net yearly addition to the aquifer storage due to the contribution from man-made sources such as sewer systems, irrigation, and water distribution networks, ranged from 8300 to 10,100 cu m/day, causing a subsurface-water level increase of about 5 m locally, resulting in high water table conditions. A maximum local rise in the water table of 2.5 m was predicted between the end of 1985 and 1990, if no remedial actions are undertaken. Preventive methods to reduce or eliminate recharge from man-made activities would help control the water level rise and even lower the water table in selected areas. Remedial measures to lower and maintain the subsurface-water level at acceptable depths would entail the withdrawal of significant quantities of groundwater. (Author's abstract)
W91-05825

EMPIRICAL BAYES REGIONALIZATION METHODS FOR SPATIAL STOCHASTIC PROCESSES.
Gradient Corp., Cambridge, MA.
J. B. Butcher, M. A. Medina, and C. M. Marin.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 7-15, January 1991. 5 fig, 2 tab, 28 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Model studies, *Spatial distribution, *Statistics, *Stochastic process, Hydraulic conductivity, Mathematical models, Performance evaluation, Risk assessment, Stochastic models.

Many geophysical properties can be described as spatial stochastic processes, including spatially correlated hydraulic conductivity fields. Use of regional data can potentially improve estimation of such processes. The case is considered in which observations at each of several sites are described by a general linear model, while the parameters of the models arise from a common regional distribution. Parametric empirical Bayes methods enable the determination of the parameters of the regional distribution via maximum likelihood. However, such methods have not been utilized for spatial stochastic processes. An application has been developed for a simple iterative technique for maximum likelihood estimation of regional parameters and its use is demonstrated with a common para-

meterization of the spatial covariance structure. Synthetic data tests show the potential for substantial reduction in estimation risk through the use of such techniques. The synthetic data tests indicate that the empirical Bayes procedures will likely underestimate precision uncertainty due to overvaluation of precision of the regional parameter estimates. Spatial variability in hydraulic conductivities can be an important factor in the analysis of groundwater contamination risk. However, it seems to be generally the case that data sufficient to characterize the spatial properties of hydraulic conductivity fields are not readily available. Demonstration of the potential value of regionalization may encourage regulatory agencies to collect and maintain such data. (Rochester-PTT)
W91-05832

HYDRAULIC RESPONSE OF HIGHLY COMPRESSIBLE AQUITARDS DURING CONSOLIDATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
D. L. Rudolph, and E. O. Frind.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 17-30, January 1991. 14 fig, 35 ref.

Descriptors: *Aquifer systems, *Aquitards, *Consolidation, *Groundwater movement, *Hydraulic properties, *Leaky aquifer systems, Clays, Compression, Errors, Leakage, Linear theory, Mexico City, Performance evaluation, Solute transport, Subsidence.

The transient behavior of highly compressible aquitards was investigated through numerical analysis and field studies. Variations in the hydraulic parameters of an aquitard during consolidation were accounted for by incorporating empirical relationships derived from standard consolidation tests into the one-dimensional flow equation. The resulting equation is highly nonlinear. The hydraulic response of an aquitard with physical properties typical of the compressible clays of Mexico City was evaluated with both standard linear analysis and a nonlinear approach where the hydraulic parameters were stress-dependent. The results indicate that decreases in the hydraulic diffusivity of the aquitard due to consolidation lead to diminished leakage flux, slower groundwater velocities, and solute transport rates, longer transient response periods, and less land subsidence than would be predicted by classical linear theory. Evaluation of field data from a site near Mexico City indicates that significant interpretive errors may arise if stress dependence of the hydraulic parameters is ignored in systems of this type. (Author's abstract)
W91-05833

LABORATORY ANALYSIS OF FLUID FLOW AND SOLUTE TRANSPORT THROUGH A FRACTURE EMBEDDED IN POROUS TUFF.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
W. R. Haldeman, Y. Chuang, T. C. Rasmussen, and D. D. Evans.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 53-65, January 1991. 8 fig, 8 tab, 30 ref. U.S. Nuclear Regulatory Commission Contract NRC-04-86-114, FIN D1662.

Descriptors: *Geologic fractures, *Groundwater movement, *Model studies, *Path of pollutants, *Solute transport, Breakthrough curves, Hydraulic conductivity, Laboratory methods, Mathematical models, Simulation, Transmissivity, Traveltime, Tuff.

Laboratory experiments were conducted to determine the flow and transport properties of a fractured porous tuff block measuring 20 x 20 x 50 cm. One porous ceramic plate was placed immediately above a fracture and two other plates were placed on either side of the fracture above the rock matrix. The plates controlled the pressure head applied to the upper surface of the fractured rock block. Laboratory results were simulated using the boundary integral method for a single saturated fracture with an assumed uniform transmissivity embedded within a porous tuff block. The simulation identified the saturated hydraulic properties of the fracture. Matrix hydraulic conductivity was estimated as 50 times 10 to the minus 9th power m/sec and the fracture transmissivity as 5 times 10 to the minus 9th power sq m/sec. Much of the flow that exits the fracture at the lower surface first passes through the rock matrix even though a direct contact exists with the porous plate. Travel times and breakthrough curves were used to estimate fracture dispersivities, which ranged from 0.0207 to 8.01 m. Breakthrough curves deviated from simulation results due to significant channeling of fracture flow. (Author's abstract)
W91-05836

STEADY FLUID FLOW AND TRAVEL TIMES IN PARTIALLY SATURATED FRACTURES USING A DISCRETE AIR-WATER INTERFACE.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
T. C. Rasmussen.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 67-76, January 1991. 8 fig, 22 ref, append. U.S. Nuclear Regulatory Commission Contract NRC-04-86-114, FIN D1662.

Descriptors: *Disposal wells, *Geologic fractures, *Groundwater movement, *Path of pollutants, *Steady flow, *Unsaturated flow, Aeration zone, Air-water interfaces, Hydraulic conductivity, Laboratory methods, Mathematical models, Simulation, Site selection, Traveltime, Waste disposal.

The characterization of fluid movement through fractured rock media of low hydraulic conductivity is critical to the evaluation of the suitability of waste disposal sites in geologic media. Fracture flow under conditions of partial fluid saturation was studied where a portion of the fracture is filled with water and the remaining portion is filled with air. A discrete air-water interface was employed to separate the saturated from the drained regions of the fracture. A laboratory flow experiment was conducted to demonstrate the interface concept. The steady-state air-water interface position was observed by maintaining a circular water source at constant positive pressure head between two vertical glass plates. An analytic solution to the flow problem was compared to the observed interface position and to simulated results that assume that a constant capillary pressure head can be assigned along the interface. Simulations performed for a hypothetical vertical fracture indicate zones of positive and negative pressure head in the saturated zone as well as an air-filled zone. For the hypothetical fracture examined, fluid travel times are not substantially changed as fracture saturation decreases. This result may not be general for all fractures. (Author's abstract)
W91-05837

LIGHT STABLE ISOTOPE SYSTEMATICS OF LARGE-SCALE HYDROLOGIC REGIMES IN CALIFORNIA AND NEVADA.
California Univ., Davis. Dept. of Geology.
For primary bibliographic entry see Field 2A.
W91-05838

GROUNDWATER CONTAMINATION STUDIES--THE STATE-OF-THE-ART.
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
For primary bibliographic entry see Field 5B.
W91-05848

ORIGIN AND MORPHOLOGY OF LIMESTONE CAVES.
State Univ. of New York Coll. at Oneonta. Dept. of Earth Sciences.
A. N. Palmer.
Geological Society of America Bulletin BUGMAF, Vol. 103, No. 1, p 1-21, January 1991. 25 fig, 1 tab, 79 ref.

Descriptors: *Caves, *Fissure water, *Geochemistry, *Geohydrology, *Groundwater movement, *Hydrology, *Karst, *Limestone, Flow discharge, Geologic control, Geologic fractures, Geomorphology, Groundwater recharge, Sinkholes, Sinks, Water chemistry.

Limestone caves form along groundwater paths of greatest discharge and solutional aggressiveness. Flow routes that acquire increasing discharge accelerate in growth, while others languish with negligible growth. As discharge increases, a maximum rate of wall retreat is approached, typically about 0.01-0.1 cm/yr, determined by chemical kinetics but nearly unaffected by further increase in discharge. The time required to reach the maximum rate is nearly independent of kinetics and varies directly with flow distance and temperature, and inversely with initial fracture width, discharge, gradient, and CO2 pressure. Most caves require 10,000-100,000 years to reach traversable size. Their patterns depend on the mode of groundwater recharge. Sinkhole recharge forms branching caves with tributaries that join downstream as higher-order passages. Maze caves form where steep gradients and great undersaturation allow many alternate paths to enlarge at similar rates or, where discharge or renewal of undersaturation is uniform along many alternate routes. Flood water can form angular networks in fractured rock, anastomotic mazes along low-angle partings, or spongework where intergranular pores are dominant. Diffuse recharge also forms networks and spongework, often aided by mixing of chemically different waters. Ramiform caves, with sequential outward branches, are formed mainly by rising thermal or H2S-rich water. Dissolution rates in cooling water increase with discharge, CO2 content, temperature, and thermal gradient; but, only at thermal gradients of more than 0.01 C/m can normal groundwater CO2 form caves without the aid of hypogenic acids or mixing. Artesian flow has no inherent tendency to form maze caves. Geologic structure and stratigraphy influence cave orientation and extent, but alone they do not determine branchwork versus maze character. (Author's abstract)
W91-05851

PRECIPITATION IN THE SOUTHERN HIGH PLAINS: METEOROLOGIC AND ISOTOPIC FEATURES.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 2B.
W91-05866

DIRECTIONAL SATURATED HYDRAULIC CONDUCTIVITY AND MACROPORE MORPHOLOGY OF A SOIL-SAPROLITE SEQUENCE.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
P. Schoeneberger, and A. Amoozegar.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 31-49, March 1990. 4 fig, 6 tab, 35 ref. Water Resources Research Institute of the University of North Carolina, Project Number 70091.

Descriptors: *Hydraulic conductivity, *Macropores, *Saprolites, *Saturated flow, *Soil structure, Geohydrology, Porous media, Soil horizons, Soil properties, Soil water.

The soils in the Piedmont and Mountain regions of the southeastern United States are characterized by the presence of saprolite at or near the soil surface. A study was conducted to describe the macropore network of a representative soil-saprolite sequence and to relate the directional saturated hydraulic conductivity of the soil profile to the water flow through macropores. Large observation pits were constructed at three geomorphic positions (ridge top, shoulder, and ridge nose). Soil-saprolite macropores and their morphology were described in the field. Triplicate intact soil cores were collected in five orientations: one vertical, two horizontal (perpendicular to each other), and two diagonals (perpendicular to each other) from the Bt, B/C, and C (massive saprolite) horizons at each of the three geomorphic positions. The saturated hydraulic conductivity (Ks) of each horizon was determined in the laboratory. In situ Ks of each horizon was also determined near the three observation

pits. Mean Ks values for the five orientations, three horizons, and three geomorphic positions ranged from 0.82 nm/sec to 2.75 microm/sec. Mean in situ Ks value ranged from 0.75 nm/sec to 2.66 microm/sec. The results indicated that no significant differences existed among the Ks values in different orientations for each horizon-landscape combination, with no exceptionally high conductivity values. The in situ Ks results generally agree with the results for the core samples. (Author's abstract)
W91-05875

FLUID FLOW IN PARTIALLY SATURATED, WELDED-NONWELDED TUFF UNITS.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
J. S. Y. Wang, and T. N. Narasimhan.
Geoderma GFDMAB, Vol. 46, No. 1/3, p 155-168, March 1990. 8 fig, 19 ref. USDOE Contract DE-AC03-76SF00098.

Descriptors: *Geologic fractures, *Groundwater movement, *Infiltration, *Soil water, *Tuff, Flow pattern, Geohydrology, Hydrologic models, Nevada, Pulse infiltration, Radioactive wastes, Seepage, Yucca Mountain.

A discrete fracture, porous matrix model and a composite medium model were used to study hydrological responses to cycles of pulse infiltration at Yucca Mountain, a potential site for a nuclear waste repository. The pulses were applied to fractures at the top of a vertical column composed of alternating layers of welded and nonwelded volcanic tuff. For average infiltration rates of 0.1 mm/yr, pulses expressed as short durations separated by periods of up to 5000 yr, most effects of the transient infiltration pulses were damped by the Paintbrush nonwelded unit. The effects of eastern tilting of the units at Yucca Mountain on the steady state fluid flow distribution were studied using a two-dimensional model; Ghost Dance Fault was modeled as a seepage face. Under the expected flux conditions, saturation increased just to the west of the fault, but the water did not enter the fault with the seepage boundary condition. (Author's abstract)
W91-05883

LAPLACE TRANSFORM GALERKIN TECHNIQUE FOR EFFICIENT TIME-CONTINUOUS SOLUTION OF SOLUTE TRANSPORT IN DOUBLE-POROSITY MEDIA.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2G.
W91-05886

USE OF TEMPORAL MOMENT ANALYSIS TO STUDY REACTIVE SOLUTE TRANSPORT IN AGGREGATED POROUS MEDIA.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-05887

ION EXCHANGE TREATMENT OF SUBSURFACE DRAINAGE WATER.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W91-05924

ESTIMATION OF THE GROUNDWATER POLLUTION POTENTIAL ON AN AGRICULTURAL WATERSHED.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W91-05931

NEW TOOL: DELINEATION OF TEXTURAL HETEROGENEITIES IN UNCONFINED AQUIFERS, USING MICROGRAVITY SURVEYS DURING PUMPING.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
E. I. Poeter.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 27, No. 3, p 315-325, 1990. 4 fig, 5 ref.

Descriptors: *Aquifer testing, *Aquifers, *Flow models, *Geophysical surveys, *Gravity surveys, *Pumping tests, *Unconfined aquifers, Alluvial aquifers, Aquifer characteristics, Gravity studies, Groundwater pollution, Hydraulic profiles, Microgravity surveys.

Hypothetical models of texturally heterogeneous aquifers indicate that microgravity surveys can be used to locate textural heterogeneities within the cone of depression caused by pumping in an unconfined aquifer. The difference in gravity between an undisturbed water table and a relatively steady drawdown cone is measured on profile lines. Small differences in gravity indicate zones of little dewatering which are typically areas where low hydraulic conductivity and/or low-specific yield materials occur near the water table. Large differences in gravity generally indicate more permeable and higher yield materials. Magnitudes of the anomalies of interest are close to the detection limit. Therefore, it is essential that gravimeters used to conduct the survey are in excellent condition and that field personnel are well-trained. Because the survey delineates zones of fine-grained material in the vicinity of the water table, microgravity surveys may be useful in design of facilities to clean up spills of immiscible fluids that are less dense than water and are substantially influenced by the texture of alluvial deposits in the vicinity of the water table. Zones of fine-grained materials typically inhibit fluid movement and often are more chemically reactive with contaminants. As a result, identification of textural differences provides initial clues to both hydraulic and chemical heterogeneity. (Author's abstract)
W91-05937

2G. Water In Soils

ESTIMATING POROSITY OF PARTIALLY SATURATED SEDIMENTS.
Connecticut Univ., Groton. Marine Sciences Inst.
J. J. Dowling.
Engineering Geology EGGOAO, Vol. 29, No. 2, p 139-147, July 1990. 2 tab, 4 fig, 14 ref.

Descriptors: *Geophysical methods, *Lake sediments, *Porosity, *Resistivity, *Sediment analysis, Electrical properties, Mathematical analysis, Sedimentology.

The electrical resistivity of an unconsolidated sediment depends on the fraction of the pore space that is filled with fluid. An empirical relation can be formed that relates measured resistivity and fluid content to the percent saturation. The formula was applied to a core taken from a freshwater lake and the volume of gas in the sediment estimated to a depth of 6 meters into the lake bottom. It is possible, after some simplifying assumptions, to combine the measured resistivity and the measured fluid content to yield a more accurate estimate of the porosity. (Feder-PTT)
W91-04940

ASSESSMENT OF VEGETATION AND SOIL WATER REGIMES IN PARTIAL CANOPIES WITH OPTICAL REMOTELY SENSED DATA.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. R. Huete, and A. W. Warrick.
Remote Sensing of the Environment RSEEA7, Vol. 32, No. 2/3, p 155-167, May/June 1990. 12 fig, 4 tab, 18 ref.

Descriptors: *Reflectance techniques, *Remote sensing, *Satellite technology, *Soil surfaces, *Soil water, *Vegetation, Aircraft, Arizona, Canopy, Cotton, Cultivated lands, Drying.

The optical properties of a partially vegetated cotton field with spatially and temporally dynamic soil water conditions were analyzed with coincident aircraft and satellite data. The study was conducted at the Maricopa Agricultural Center in Arizona during June 1988. The dynamics of soil surface drying made it difficult to evaluate plant cover and assess soil condition with combined thermal, brightness, and normalized difference vegetation index spectral parameters as all three parameters were sensitive to the three stages of soil drying. A soil-adjusted vegetation index minimized both spatial and temporal variations in soil spectral behavior and was found useful in vegetation analysis and in further qualitative assessment of soil condition. Due to the complex dynamics of soil surface drying and variability in soil properties, soil water content at the surface (0-5 cm) could not be determined with the Thematic Mapper moisture bands, or with the various wetness indicators. (Author's abstract)
W91-05032

PRODUCTION AND TRANSPORT OF CARBON DIOXIDE IN A CONTAMINATED VADOSE ZONE: A STABLE AND RADIOACTIVE CARBON ISOTOPE STUDY.
Arizona Univ., Tucson. Environmental Radioisotope Center.
For primary bibliographic entry see Field 5B.
W91-05072

KINETICS OF SELENATE AND SELENITE ADSORPTION/DESORPTION AT THE GOETHITE/WATER INTERFACE.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5B.
W91-05075

DERIVATION OF INFILTRATION EQUATION USING SYSTEMS APPROACH.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and F. X. Yu.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 837-858, November/December 1990. 5 fig, 5 tab, 13 ref, append.

Descriptors: *Infiltration, *Mathematical equations, *Model studies, *Soil water, *Systems analysis, Absorbers, Hydrologic models, Mathematical models, Performance evaluation, Soil properties.

The infiltration process can be represented by a systems approach, which uses an absorber or a network of absorbers. Infiltration constitutes the input to the absorber. An absorber can be defined by a relation between its moisture content and the rate of infiltration to it. A general definition of the absorber was suggested. A general infiltration model was derived by coupling this general relation with the spatially lumped form of the continuity equation to be satisfied by the absorber. The models of Horton, Kostiakov, Overton, Green and Ampt, and Philip are some of the models that were shown to be special cases of the general model. An equivalence between the Green-Ampt model and the Philip two-term model was shown. The general model also provides a solution for the Holtan model expressing infiltration as a function of time. A first-order analysis was performed to quantify the uncertainty involved in the generalized model. The general infiltration model contains five parameters. Two of the parameters are physically based and therefore can be estimated from the knowledge of soil properties, antecedent soil moisture conditions, and infiltration measurements. The remaining three parameters can be determined using the least squares method. The model was verified using 10 data sets of observed infiltration. Agreement between observed and computed infiltration was quite good. (Author's abstract)
W91-05136

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: II. WATER UPTAKE IN RELATION TO ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Aus-

tralian Environmental Studies.
For primary bibliographic entry see Field 2I.
W91-05162

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: III. WATER UPTAKE IN RELATION TO SOIL HYDRAULIC CONDUCTIVITY AND ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
J. Eastham, C. W. Rose, D. M. Cameron, S. J. Rance, and T. Talsma.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 4, p 709-718, 1990. 6 fig, 1 tab, 24 ref.

Descriptors: *Pastures, *Soil properties, *Trees, *Soil water, *Soil-water-plant relationships, Hydraulic properties, Transpiration, *Root distribution, *Hydraulic conductivity, Forests, Agriculture, Soil horizons.

Tree transpiration was studied at three tree planting densities in an agroforestry experiment over a period of approximately one year and related to rooting patterns and soil hydraulic properties. Over the range of soil water contents studied, the ratio of tree transpiration to equilibrium evaporation rate (T/E) declined linearly with decreasing mean soil water content at each tree density. To investigate the effects of soil hydraulic conductivity and root length density on the total transpirational flux, overall soil conductances (K) were calculated, with soil conductances in each horizon weighted according to the length of root in that horizon. At each tree density, decreases in the ratio T/E were related to decreases in ln K measured at 1 to 2 m from the stem. A more rapid decrease in T/E with decrease in water content observed at low tree density was due to a greater decline in K as mean water contents decreased. The greater decline in K at low tree densities was associated with a larger proportion of water extracted and a higher proportion of total root length in surface soil horizons, which showed a greater decrease in hydraulic conductivity than subsoil horizons for the same decrease in water content. (See also W91-05161 and W91-05162) (Author's abstract)
W91-05163

SIMULATION OF WATER FLOW FROM A PERCOLATION TEST HOLE IN LAYERED SOIL.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
J. D. Jabro, and D. D. Fritton.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1214-1218, September/October 1990. 3 fig, 28 ref.

Descriptors: *Model studies, *Soil properties, *Soil water, Finite element method, *Mathematical models, *Hydrologic models, *Percolation tests, Computer programs, *Hydraulic conductivity, Saturation, Soil types, Soil horizons, Saturation zones, Groundwater movement.

A finite-element program (TWODEPEP) was used to solve Richard's water flow equation in cylindrical coordinates in order to better explain problems in the correlation of percolation tests and soil hydraulic conductivity data. Both saturated and unsaturated aspects of water flow from a percolation test hole were simulated. Inputs for the simulation model were the soil hydraulic conductivity, which was measured using the Guelph permeameter technique, and water-retention data for each layer of a Monongahela silt loam soil (a fine-loamy, mixed, mesic Typic Fragiudult). Pressure-head distribution and rate of water flow were simulated. A thin (approximately 10 mm) saturated zone near the water source, approximated by the region inside the zero-pressure line, was nearly constant in size with time, but the wetting front continued to advance. The horizontal movement of water in the soil was dominant over the downward vertical movement due to the movement of the water in both the upper and middle layer rather than the lower layer because the soil in these two layers was more permeable than the underlying layer. Simulated flow results agreed with the geometric mean of the field data obtained at six sites. The simulated results in the layered soil were compared with those in a uniform soil to show how soil layers significantly affect water flow from a percolation test hole. (Author's abstract)
W91-05175

ANALYSIS OF INFILTRATION THROUGH A TWO-LAYER SOIL PROFILE.
Agricultural Research Service, Fort Collins, CO.
R. E. Smith.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1219-1227, September/October 1990. 13 fig, 28 ref.

Descriptors: *Soil properties, *Soil water, Heterogeniety, *Soil profiles, *Infiltration, *Groundwater movement, *Mathematical models, *Model studies, Boundary conditions, Saturation zones, Ponding, Soil types, Fluctuations.

Most soils in nature exhibit some degree of layering, while infiltration theory is largely confined to homogeneous profiles. This study was conducted to describe general infiltration features of a two-layer system, including the often-studied crust case as a limit. The general analytic theory for infiltration models leads to several related robust relations for homogeneous soils. The resulting analytic expressions relate infiltratability (f) to infiltrated water (I). This type of expression is uniquely general in describing the decay of f with I for either saturation or flux boundary conditions, and in describing the onset of ponding for flux boundary conditions. This study explores the applicability of this theory when the soil profile is composed of two layers. A numerical solution of Richard's equation is used as an experimental tool, applied to a general set of possible soil changes that may occur at the layer interface. The special case of layers with absorption matched infiltrability parameters exhibits complex behavior when the interface is encountered at large I. The behavior of the layered system exhibits the same unifying f(I) response to flux boundary conditions as does a homogeneous profile, which lends unexpected generality to the I-based analytical infiltration model. (Author's abstract)
W91-05176

PONDED INFILTRATION FROM A SINGLE RING: I. ANALYSIS OF STEADY FLOW.
Agriculture Canada, Ottawa (Ontario). Land Resource Research Centre.
W. D. Reynolds, and D. E. Elrick.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1233-1241, September/October 1990. 7 fig, 7 tab, 21 ref.

Descriptors: Hydraulic properties, *Soil properties, *Steady flow, *Infiltration, *Ponding, *Hydraulic conductivity, *Soil water, Mathematical models, Model studies, Matric flux potential, Error analysis, Pressure head.

A new analysis of steady, ponded infiltration from within a single ring takes soil hydraulic properties, ring radius, depth of ring insertion, and depth of ponding into account, and provides a means for determining the field-saturated hydraulic conductivity (K) and the matric flux potential (MFP). The analysis employs numerically determined shape factors (G) that are found to depend significantly on ring radius (a) and depth of ring insertion (d), but only slightly on depth of ponding (H) and soil hydraulic properties. As a consequence, averaged G values can be developed for specified d and a that apply to a wide range of ponded heads and soil types. Procedures for calculating K and MFP are based on G or average G values and on the ponding of one, two, or multiple H levels in the ring. Test calculations based on averaged G suggest that K can be obtained with an accuracy of about +/-20% for H = 0.05 to 0.25 m and a = 1/m to 36/m, where a is the soil parameter of the exponential hydraulic conductivity-pressure head relationship. A similar level of accuracy is obtained for MFP when a is small (a <= 4/m), and when both a and H are large (a > 4/m, H >= 0.20 m). Significant errors in MFP can occur, however, when a is large but H is small. Potentially important features of this single ring method include low sensitivity of the K calculation to errors in averaged G reduced measurement errors resulting from small-scale soil variability, and the ability to pond large heads in order to increase flow rates in low-permeability materials. (Author's abstract)
W91-05177

EFFECT OF PH ON PERMEABILITY OF CLAY-SAND MIXTURE CONTAINING HYDROXY POLYMERS.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
R. Keren, and M. J. Singer.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1310-1315, September/October 1990. 6 fig, 17 ref.

Descriptors: *Soil properties, *Soil water, Aluminum, Iron, *Groundwater movement, *Permeability, *Clay, *Sand, Soil types, *Hydraulic conductivity, Saturation zones, Electrolytes, *Hydrogen ion concentration, Leachates, Hydroxy polymers, Adsorption.

Whether the effectiveness of hydroxy-aluminum and hydroxy-iron polymers in stabilizing the hydraulic conductivity of smectite-sand mixture increases with their charge density was investigated. The effect of pH 5.5 and 7.5 on the saturated hydraulic conductivity (HC) of sodium/calcium-smectite-sand mixtures (5% clay and 95% sand) and in the presence of hydroxy-aluminum and hydroxy-iron polymers was studied by leaching with sodium chloride-calcium chloride solutions at sodium adsorption ratios (SAR) of 10 and 20 of electrolyte concentrations of 500, 100, 50, 10, 5, 3, 2, and 1 mol/cubic m and deionized water. The HC of the mixtures essentially remained unchanged as long as the electrolyte concentration of the leachate was >= 50 mol/cubic m. A further decrease of the solution concentration produced a drop in HC for both the untreated and treated systems at pH 7.5. No HC reduction occurred at pH 5.5 when hydroxy-aluminum polymers were present. The HC of both treated and untreated systems at pH 5.5 was higher than that at pH 7.5. The HC reduction was two and three orders of magnitude smaller for the treated systems than for the systems without hydroxy polymers. Hydroxy-iron polymers also reduced the effect of electrolyte concentration in the leaching solution on the HC of the clay-sand mixture, but to a lesser extent. The effect of pH on the charge density of the hydroxy polymers explained their effectiveness in stabilizing the system at the lower pH. The lower HC of the clay-sand mixture in the presence of hydroxy-iron polymers suggests that the aggregates with this polymer are weaker than those with hydroxy-aluminum polymers. This difference in stability is due to the higher point of zero charge for the hydroxy-aluminum polymers. (Author's abstract)
W91-05182

WATER BALANCE ESTIMATION MODEL: FIELD TEST AND SENSITIVITY ANALYSIS.
Institut des Savanes, Bouake (Ivory Coast).
J. L. Chopart, and M. Vauclin.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1377-1384, September/October 1990. 5 fig, 6 tab, 24 ref. AIEA Cooperative Project IVC/5/012.

Descriptors: *Hydrologic budget, *Soil-water-plant-relationships, *Mathematical models, *Model studies, *Sensitivity analysis, Atmosphere, Evaporation, Root distribution, Plant growth, Soil water, *Evapotranspiration, Error analysis, Drainage, Agriculture, Lysimeters, Drought.

A simplified, capacity-based simulation model has been developed to predict components of the field water balance, requiring only daily information such as the atmospheric evaporative demand and soil-wetting events, maximum available soil water storage, and root growth characteristics, as well as crop and soil parameters. Actual evapotranspira-

tion was modeled using Eagleman's parameterization. The model was tested for upland rice grown on a 3500 sq m field plot, and on an undisturbed lysimeter. The predicted actual evapotranspiration (AET) and drainage (D) at the bottom of the soil profile matched the lysimeter data. Also, the model predicted reasonably well the field soil water content data, which were obtained at 15 sites. In the latter case, the root mean square error was about 16% for the seasonal AET, and 19% for D. Errors were within the limits of experimental uncertainties expected when such measurements are analyzed by Darcy's law. The results of a sensitivity analysis with respect to changes in parameter inputs show that the model is physically realistic. However, the sensitivity depends strongly on the supply of water in the soil. This clearly justifies the need to simulate the root-zone water balance as a time-dependent process, especially if there is a practical interest in accurate prediction during drought periods. (Author's abstract)28 Nov 90
W91-05183

ANTECEDENT WATER CONTENT AND RAINFALL ENERGY INFLUENCE ON SOIL AGGREGATE BREAKDOWN.
National Soil Erosion Lab., West Lafayette, IN.
For primary bibliographic entry see Field 2J.
W91-05184

WICK TENSIOMETER TO MEASURE LOW TENSIONS IN COARSE SOILS.
Battelle Pacific Northwest Labs., Richland, WA.
G. W. Gee, and M. D. Campbell.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1498-1500, September/October 1990. 3 fig, 1 tab, 32 ref. US DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Measuring instruments, Soil texture, Soil properties, Sensors, Particle size, *Tensiometers, *Soil water, *Water pressure, Soil types, *Sands, *Gravels, Matric potential.

A wick tensiometer was constructed was constructed to measure soil water pressures or tensions in coarse sands and gravelly soils. The tensiometer is similar in design to a conventional tensiometer except that a flexible wick material is used instead of a ceramic cup. Soil matric potential (reported as tension) or water pressure is sensed by the wick and monitored with a pressure transducer or hanging water column. Several wick materials were tested. Absorbent towelling, rolled to form a tight cylinder and sealed into a tensiometer body by a compression fitting, measured tensions up to 90 cm successfully. Glass-fiber filter paper and wettable plastic sheeting were also tested successfully. Initial tests indicated that the wick sensor was as responsive to tension changes in gravelly soil as ceramic cup units and was likely to break during placement. (Author's abstract)
W91-05188

VOLUME RECORDER FOR LYSIMETER WATERS.
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
P. W. Hazlett, M. C. English, and N. W. Foster.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1503-1505, September/October 1990. 1 fig, 2 tab, 10 ref.

Descriptors: *Measuring instruments, *Flow measurements, *Groundwater movement, *Volumetric analysis, Performance evaluation, Automation, *Lysimeters, *Soil water, Water sampling, Field tests, Portability.

Water moving through the soil can be sampled by a variety of lysimeters, but in many cases the volume of water exceeds the capacity of the collection vessel. The design of a simple and inexpensive volume recorder used to measure large volumes of soil water from individual lysimeters included the connection of Tygon tubing to individual collection vessels, which were modified 15 L lowboy carboys with a siphon apparatus to empty the vessel when it was full and a counting mechanism to record the number of times the vessel had filled and drained. During tests in the field, the volume recorder provided good estimates of water volumes collected by tension-free lysimeters. The compactness and easy portability of the unit makes it ideal for year-round use at remote field locations to determine variability in the flow of soil water. (Author's abstract)
W91-05189

FORMATION AND PHYSICAL STATE OF LEACHED FERRALLITIC SAVANNA SOILS OF MALI.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 2J.
W91-05215

WATER REGIME OF SHELTERBELTS IN A DRY STEPPE ZONE.
Moscow State Univ. (USSR). Dept. of Soil Science.
L. O. Karpachevskiy, L. B. Borovinskaya, and D. D. Khaydapova.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 76-89, 1989. 4 fig, 5 tab, 5 ref.

Descriptors: *Arid lands, *Trees, Soil moisture deficiency, Soil water suction, *Soil water, *Steppes, *Shelterbelts, Temporal distribution, *Plant growth, Soil types, Light intensity, Soil water potential.

The moisture regime of light Chestnut soils under shelterbelts was examined over a 30-year period. Differentiation of the water regime at the edge and in the center of the shelterbelt was observed, and basal area growth at the edge and in the center of shelterbelts varied according to the type of light regime. Growth of shelterbelts was accompanied by a change in soil moisture loss in the row and distance between rows. Beginning with the seventeenth year, the growth of trees in the shelterbelts ceased to increase, and in most cases, decreased. The water potential of the soil under shelterbelts decreases sharply. The suction force of trees is very high. Shelterbelts on light chestnut soils experience an acute moisture deficit, which increases gradually. Gradually the low level of water content and soil water potential leads to cessation of tree growth. (Brunone-PTT)
W91-05218

NATURE OF PERMEABILITY IN FINE-TEXTURED SOILS.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
Z. A. Kapilevich, L. K. Tselishcheva, and A. V. Vysochenko.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 90-99, 1989. 3 fig, 1 tab, 9 ref.

Descriptors: *Soil water, *Permeability, *Soil texture, Soil types, Permeability coefficient, *Waterlogging, *Soil porosity, *Soil genesis, Infiltration coefficient, Reclaimed water, Hydraulic engineering, Soil horizons.

Permeability is shown to be controlled by the genetic characteristics of soils and by the anthropic factor. Changes in parent material during soil formation, microaggregate and macroaggregate composition, cracking, and micromorphometric characteristics of pore space are closely associated with the degree of gleying. With waterlogging, dispersion and microporosity increase, and the infiltration coefficient decreases in more waterlogged soils. Reclamation by hydraulic engineering contributes to an increase in the number of water-conducting pores, the loss of mineral organic matter, and the infiltration coefficient of plow and upper alluvial horizons. However, even after drainage, gley soils have lower infiltration coefficients than gleyey and temporarily overly wet soils. (Brunone-PTT)
W91-05219

SOIL FORMATION IN CULTIVATED, COARSE-TEXTURED SOD-PODZOLIC SOILS WITH CHEMICAL USE.
Velikie Luki Agricultural Inst., Lenina (USSR).
A. A. Korotkov, L. F. Ippolitova, and Y. I. Kravchuk.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 100-108, 1989. 10 tab, 10 ref.

Descriptors: *Agricultural chemicals, *Podzols, *Soil chemistry, *Soil genesis, *Soil texture, *Soil water, Leaching, Precipitation, Fertilizers, Nutrient concentrations, Percolation, Organic matter.

Cultivated sod/podzolic sandy soils have the following soil-formation characteristics: (1) intensive leaching of the upper part of the profile during the spring and autumn, and during the growing season in years with large amounts of precipitation; (2) leaching of a significant quantity of nitrogen and ash nutrient elements, and increased leaching with increasing rates of fertilizer application; (3) greater importance of strong-acid anions in the leaching of bases compared to bicarbonate ion; (4) distinct predominance of mineralization of organic fertilizers and post-harvest residues over humification; and (5) a 'zero' balance of humus with extensive chemical use and a positive balance with intensive chemical use. With intensive chemical use, there is a clear positive balance for nitrogen, phosphorus, and potassium; a weak positive balance of calcium; and a negative balance for magnesium. The input component of nutrients with post-harvest residues is quite arbitrary, since these elements are taken from the soil and fertilizers by plants. If this component is excluded from the input components, then only nitrogen, phosphorus, and potassium have positive balances, while calcium has a negative or nearly-negative balance and magnesium has a very negative balance. With both extensive and intensive chemical use, calcium-bearing minerals are hydrolyzed in the plow layer of poorly-buffered sandy soils influenced by fulvic acids, low-molecular-weight organic acids, and mineral acids that form with the application of acid mineral fertilizers. Thus, weathering of the aluminosilicate part of the soil does not cease on cultivated land; it merely occurs to varying degrees as a function of the content of substances of neutralizing the products responsible for the hydrolysis. (Brunone-PTT)
W91-05220

NITROGEN LOSSES FROM THE SOIL WITH INFILTRATING WATER IN A FERTILIZED PINE STAND.
Belorussion Scientific-Research Institute of Forestry, USSR.
For primary bibliographic entry see Field 5B.
W91-05223

REMOVAL OF NATURAL RADIONUCLIDES FROM SOIL IN LYSIMETRIC WATER.
For primary bibliographic entry see Field 5B.
W91-05225

DEGRADATION OF CHERNOZEMS ON THE DANUBE-DNIESTER IRRIGATION SYSTEM.
Odessa Agricultural Inst. (USSR).
For primary bibliographic entry see Field 3C.
W91-05227

PROPERTIES OF SURFACE WATERLOGGED CLAY SOILS CONTAINING EXCHANGEABLE MG.
Polytechnic Institute, Sofia, Bulgaria.
T. D. Palaveyev, and M. D. Penkov.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 87-96, 1990. 6 tab, 27 ref.

Descriptors: *Clay soils, Illite, Soil saturation, *Soil water, *Cation exchange, *Magnesium, *Soil physical properties, Soil horizons, Model studies, Percolation, *Waterlogging, Coagulation.

Clay soils with a high content of exchangeable magnesium are widespread in nature. Chemical parameters were established which describe the specific nature of exchangeable magnesium ions in clay soils, soil horizons and in the model laboratory system: salt compounds and clay soil. Model results showed the harmful effect of a large amount of exchangeable magnesium on percolation

in clay soils. A relationship was established between the rate of percolation and the content of clay minerals with a mobile lattice and their saturation with exchangeable magnesium. The effect of calcium sulfate on percolation in clay soils with a high content of exchangeable magnesium is due to desorption, expansion of illite and increased coagulation of clay by virtue of a more complete saturation of soils with exchangeable calcium ions and to increased concentration of calcium ions in the soil solution. (Brunone-PTT)
W91-05228

SALINE MARITIME SOILS OF ESTONIA.
Tallinn Botanical Garden (USSR).
E. L. Puurmann, and U. A. Ratas.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 25-31, 1990. 2 fig, 3 tab, 7 ref.

Descriptors: *Soil chemistry, *Tidal floods, *Coastal environment, *Soil water, *Saline soils, *Estonia, Hydrological regime, Sea water, Groundwater, Trace minerals, Nutrient concentrations, Seasonal variation.

Saline maritime soils are widespread in the coastal zone of Estonia. Temporary flooding of the soils by sea water plays a decisive role in their formation and unique air and water regimes as well as the content and distribution of chemical elements along the profile both during temporary flooding and through groundwater. These soils have a high mineral content, are spatially inhomogeneous, and show pronounced seasonal dynamics in various parts of the coast. The content of sodium and chlorine in the soil is lowest in the spring, when the sea level is low and the soils are leached by rains and meltwater, and increases in summer when air temperature is higher and transpiration is intense. Groundwater is of great importance in the formation of saline maritime soils after the recession of floodwater. The highest content of elements in soil water was observed in saline maritime gley soils on the lower part of the grassy shore. (Brunone-PTT)
W91-05229

ORTSTEINS IN SOD-CALCAREOUS LEACHED AND SOD-GLEY CALCAREOUS SOILS ON PERMIAN CLAY ELUVIUM.
Akademiya Nauk SSSR, Moscow. Pochvennyi Inst.
For primary bibliographic entry see Field 2K.
W91-05230

COMPARISON OF MODELS OF PHOSPHATE SORPTION BY SOILS.
Vsesoyuznaya Akademiya Sel'skokhozyaystvennykh Nauk, Leningrad (USSR). Agrofizicheskii Nauchno-Issledovatel'skii Inst.
For primary bibliographic entry see Field 2K.
W91-05231

EFFECT OF FERTILIZER PHOSPHATES ON SOLUBILITY OF CA, MG, MN, AL, AND FE COMPOUNDS IN GRAY FOREST SOIL.
Institute of Applied Physics, Pushkino (USSR).
For primary bibliographic entry see Field 2K.
W91-05232

WATER PERMEABILITY OF FROZEN SOILS UNDER TREE STANDS IN THE FOREST-STEPPE ZONE.
Soyuzgiproleskhoz Research and Design Institute, Moscow, USSR.
N. A. Rybakova.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 106-112, 1990. 3 tab, 12 ref.

Descriptors: *Soil-water-plant relationships, *Forest hydrology, *Permeability, *Frozen ground, *Forest soils, *Steppes, Freezing, Runoff, Snowmelt, Thawing, Agriculture, Soil water.

Tree stands of the forest-steppe zone play a major water-protective role by their ability to absorb surface runoff from farmland that is polluted by fine earth, fertilizers, and pesticides and to convert this runoff to soil and ground water. The permeability of soils is shown to depend on their depth of freezing and moisture content. Because 75 to 90% of the annual runoff in the forest-steppe zone of the European USSR comes from spring meltwater, it is important to evaluate the uptake of this water by frozen soils. In a natural maple-linden-oak stand and in pine, birch and larch plantations the infiltration of water into frozen loam before thawing averages 0.01 mm/min and increases to 0.08 mm/min during thawing, an increase three to four times as great as in a cultivated field. With a depth of freezing of more than 1 m, no water seeps into the frozen soil. The permeability of frozen soil can be calculated from its depth of freezing. The permeability of frozen soil was highest (up to 3 mm/min) in natural tree stands. This permeability remained relatively high (0.2 m/min) when the depth of freezing was more than 1 m if there was no ice layer under the forest litter. (Brunone-PTT)
W91-05233

RELATIONSHIP BETWEEN MOISTURE CAPACITY AND BULK DENSITY OF PODZOLIZED CHERNOZEM.
Uman Agricultural Institute, USSR.
V. P. Gordiyenko, and P. V. Kostogryz.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 113-120, 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Soil absorption, *Soil density, *Podzols, Soil structure, Capillary capacity, Soil compaction, *Soil water, *Density, *Chernozems, Correlation analysis, Model studies, Soil physical properties.

A close relationship exists between the capillary and minimum moisture capacities of podsolized Chernozems and their bulk density within 0.90 to 1.65 g/cc. Statistical models of this relationship are developed using the bulk density of the soil, the capillary moisture capacity, percent by volume, and the correlation ratio (and its statistical error). The results and known agrophysical patterns are used to derive mathematical equations relating some structural elements of the soil to its bulk density. The minimum moisture capacity decreases with respect to soil weight, and this decrease becomes particularly pronounced when compaction increases to more than 1.3 g/cc. The mathematical equations can be used to predict the change in structure of the soil as a function of its bulk density. (Brunone-PTT)
W91-05234

PETROLEUM CONTAMINATED SOILS. VOLUME 2: REMEDIATION TECHNIQUES, ENVIRONMENTAL FATE, RISK ASSESSMENT, ANALYTICAL METHODOLOGIES.
For primary bibliographic entry see Field 5G.
W91-05236

THREE COMMON MISCONCEPTIONS CONCERNING THE FATE AND CLEANUP OF PETROLEUM PRODUCTS IN SOIL AND GROUNDWATER.
Dragun Corp., Berkley, MI.
For primary bibliographic entry see Field 5B.
W91-05249

EFFECT OF WATER-SOLUBLE ORGANIC MATERIAL ON THE TRANSPORT OF PHENANTHRENE IN SOIL.
Weston (Roy F.), Inc., West Chester, PA.
For primary bibliographic entry see Field 5B.
W91-05250

ENHANCED BIOREMEDIATION TECHNIQUES FOR IN SITU AND ONSITE TREATMENT OF PETROLEUM CONTAMINATED SOILS AND GROUNDWATER.
C.A.A. Bioremediation Systems, Boston, MA.
For primary bibliographic entry see Field 5G.
W91-05252

THERMAL DESORPTION OF HAZARDOUS AND TOXIC ORGANIC COMPOUNDS FROM SOIL MATRICES.
For primary bibliographic entry see Field 5G.
W91-05256

HOT MIX ASPHALT TECHNOLOGY AND THE CLEANING OF CONTAMINATED SOIL.
Brox (George), Inc., Dracut, MA.
For primary bibliographic entry see Field 5G.
W91-05257

REMOVING PETROLEUM PRODUCTS FROM SOILS WITH OZONE, ULTRAVIOLET, ULTRASONICS, AND ULTRAPURE WATER.
Excalibur Enterprises, Inc., New York.
For primary bibliographic entry see Field 5G.
W91-05258

CLEANUP OF A GASOLINE CONTAMINATED SITE USING VACUUM EXTRACTION TECHNOLOGY.
Terra Vac, Inc., Princeton, NJ.
For primary bibliographic entry see Field 5G.
W91-05259

ASSESSMENT AND REMEDIATION OF RESIDENTIAL PROPERTIES CONTAMINATED WITH HOME HEATING OIL: CASE STUDIES.
Haley and Aldrich, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5G.
W91-05262

OVERVIEW AND SUGGESTED METHODOLOGY TO DETERMINE THE ADEQUACY OF CLEANUP OF CONTAMINATED SOILS.
Environmental Protection Systems, Inc., Fairlawn, NJ.
For primary bibliographic entry see Field 5G.
W91-05263

PRODUCTION AND STABILITY OF ETHYLENE IN SOIL.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
M. Arshad, and W. T. Frankenberger.
Biology and Fertility of Soils BFSOEE, Vol. 10, No. 1, p 29-34, 1990. 2 fig, 2 tab, 24 ref.

Descriptors: *Ethylene, *Soil environment, *Saturated soils, *Soil tests, *Plant growth substances, *Soil water, Soil bacteria, Soil fungi, Soil chemistry, Amino acids, Waterlogging, Glucose.

One of the major factors affecting the production and stability of ethylene (C2H4) in soil is its water content. A study was conducted to determine the effect of unsaturated versus saturated conditions on the production and stability of C2H4 in soil. L-Methionine and D-glucose were added alone and in combination at 1.0 and 5.0 g/kg soil, respectively. The addition of L-methionine significantly promoted C2H4 production at field capacity to a much greater extent than under water logged conditions. Glucose was equally effective under both moisture regimes, while the combined application of both amendments (L-methionine and D-glucose) led to the release of significantly higher amounts of C2H4 under saturated conditions. Antibiotic experiments revealed that under aerobic conditions, L-methionine may be more efficiently converted to C2H4 by soil fungi, while in glucose-amended soil, both bacteria and fungi are active in generating C2H4. C2H4 was more stable under saturated conditions. The magnitude of C2H4 removal from the headspace after 3 days of incubation under unsaturated conditions (25.7%) was comparable to that after 6 days under saturated conditions (24.1%). The loss of C2H4 was approximately 10-fold greater in non-sterilized soil than in sterilized (autoclaved) soil, both maintained at field capacity, indicating that a biotic component has a major influence on C2H4 stability. Kinetic analysis revealed that the C2H4 loss-degradation in non-autoclaved soil under aerobic conditions followed a first order reaction, with a rate constant of 0.115/day and a half-life of 6.0 days. (Author's abstract)
W91-05337

COPPER AND ZINC SORPTION ON SOME B HORIZONS OF QUEBEC SOILS.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
For primary bibliographic entry see Field 5B.
W91-05338

EFFECT OF SULPHUR DIOXIDE ON EXTRACTABLE MANGANESE IN SOILS.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
For primary bibliographic entry see Field 5B.
W91-05339

SIMPLE BIOASSAY FOR THE DIAGNOSIS OF ALUMINIUM TOXICITY IN SOILS.
Queensland Dept. of Primary Industries, Indooroopilly (Australia). Agricultural Chemistry Branch.
For primary bibliographic entry see Field 5A.
W91-05340

EFFECTS OF LEACHING SURFACE-APPLIED AMENDMENTS ON SUBSOIL ALUMINUM AND ALFALFA GROWTH IN A LOUISIANA ULTISOL.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-05341

EQUATIONS TO CALCULATE THE APPROXIMATE DURATION AND TERMINATION OF THE MAXIMAL RATE PHASE OF NITRIFICATION IN SOIL.
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-05342

BIOGEOCHEMISTRY OF NITROGEN IN AGRICULTURAL LANDSCAPES.
Institut Fotosinteza, Pushkino SSR).
V. N. Bashkin.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 12-19, 1989. 14 ref. Translated from: Pochvovedeniye, No. 7, p 145-153, 1988.

Descriptors: *Nitrogen, *Agricultural watersheds, *Soil chemistry, *Geochemistry, *Cultivated land, Path of pollutants, Soil properties, Soil analysis, Fertilizers, Nitrogen cycle, Soil contamination, Moscow, Cuba, *Biogeochemistry, *Nonpoint pollution sources.

The entry of large amounts of nitrogen (as nitrogen fertilizers) into geochemical landscapes affects all components of its biogeochemical cycle. The extent to which the undesirable ecological consequences of intensive use of mineral nitrogen fertilizers are manifested is largely dependent on the types of elementary agricultural landscapes, their soil-geochemical conditions, and their association in soil-geochemical catenas. The change in excess nitrogen accumulation is considered by evaluating its landscape-agrogoechemical balance within two soil-geochemical catenas, which are a soil-geochemical calcium carbonate catena of an accumulative plain (variously eroded Gray Forest soils in the Oka River valley from its watershed to the floodplain, and floodplain soil; Moscow Oblast), and a subsoil-water soil-geochemical catena of a humid tropical zone (Ferralitic-quartzite yellow-reddish lessive soil in various degrees of erosion and gleyed humus soils of Juventud Island, Cuba). Within the calcium carbonate catena, the accumulation of nitrogen was most pronounced in the superaqual landscape, which also suffered the greatest adverse ecological consequences of intensive fertilizer use. For the tropical catena, intensive use of mineral nitrogen fertilizers on grapefruit plantations in the autonomous eluvial and transeluvial landscapes caused undesirable ecological consequences, manifested primarily in the superaqual landscape. The biogeochemistry of nitrogen in the agricultural landscape is governed to the greater degree by the amounts of mineral fertilizers applied. As a result, the biogeochemical cycle of nitrogen becomes open, the rate of its migration increases sharply, and the significance of various barriers is increased. (VerNooy-PTT)
W91-05349

NATURE AND MECHANISMS OF FORMATION OF METAL-HUMUS COMPLEXES.
Moscow State Univ. (USSR). Dept. of Soil Science.
D. S. Orlov, O. I. Min'ko, V. V. Demin, V. G. Sal'nikov, and N. B. Izmaylova.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 32-41, 1989. 4 fig, 19 ref. Translated from: Pochvovedeniye, No. 9, p 43-52, 1988.

Descriptors: Humic acids, *Metal complexes, *Decomposing organic matter, *Soil chemistry, *Chelating agents, Chemical interactions, Soil profiles, Soil properties, Molecular structure, *Path of pollutants.

Heteropolar and complex metal-humus compounds play an extremely important role in the genetic profile of soils and in their fertility. Humic substances interact with the mineral components of soils, forming organo-mineral compounds of various compositions as a result of the presence of a large variety of functional groups at high concentrations in soil material. Structures formed when metals (e.g., iron) act as bridges between different humus molecules are discussed. Ethylenediamine tetraacetic acid (EDTA) was added to a solution of humic substances, which presumably included metal-humus complexes. The introduction of EDTA to the solution caused breakdown of the macromolecules and extraction of metals. The data indicate that the reaction of the humic substances (HS) with EDTA is relatively slow, and that the highest-molecular-weight fraction of HS owes its existence to cations of several metals that form bridge bonds between different molecules of HS. Extracting these metals with EDTA broke down the large complex molecules. The ability of metals to act as bridges between different humus molecules requires more profound study, since it directly affects several important aspects of the genesis and chemistry of soils, including the conditions, form and migration rates of metals in soil profiles. (VerNooy-PTT)
W91-05350

LEACHING OF SALINE SOILS IN THE OMSK OBLAST BY DEEP FURROW IRRIGATION.
Omsk Agricultural Inst. (USSR).
A. A. Litovchenko.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 59-66, 1989. 3 tab, 7 ref. Translated from: Pochvovedeniye, No. 5, p 92-96, 1988.

Descriptors: *Saline soils, *Furrow irrigation, *Desalination, *Leaching, *Soil treatment, *Irrigation effects, Omsk, USSR, Crop yield, Demineralization, Groundwater, Brines, Soil properties.

Chernozems of the Omsk Oblast are the most extensively reclaimed soils. Owing to unique biochemical conditions, they have a number of provincial characteristics: on prolonged and deep freezing only thin and moderately thick Chernozems are formed. Experimental industrial leachings of Chernozem soils at the 'Novoomsk' sovkhoz of Omst Oblast by deep furrow irrigation was studied during 1977 to 1982. During this time leaching technology has considerably improved and it was established that leaching requirements are 3000 to 7500 cu m/ha at a salt content of 0.4 to 3.0% in the surface layer. The method of leaching consists in delivering water to the field in deep furrows alternately rather than in all furrows at once, i.e., a system of uniformly alternating water-supply and salt-discharge furrows is used. Preparation of the field for leaching is best begun after harvest of the basic crop, i.e., at the end of August, when the movement of salts to the soil surface decreases and salts have already accumulated in the zone of aeration during the past growing season. The top meter layer of soils is desalinized in 15 to 30 days, and the yield after leaching increases 2.4 to 25 fold. Salinization is slowly restored in plow and subplow horizons at water table depths of 1.3 to 1.7 meters in systems operating without drainage. In this leaching method, infiltration increases and levels off; groundwaters are demineralized; salts with brines are permanently removed from the leached field (full-scale desalinization is achieved); and 1.4 to 3.1 times less water is used for leaching compared to leaching by continuous flooding. (VerNooy-PTT)
W91-05351

HEURISTIC MODEL OF PORE SPACE FOR IMITATION OF MOISTURE-TRANSPORT IN STRUCTURED SOILS.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrotekhniki i Melioratsii, Moscow (USSR).
A. M. Zeyliger.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 94-98, 1989. 4 ref. Translated from Pochvovedeniye, No. 5, p 92-96, 1988.

Descriptors: *Mathematical models, *Model studies, *Interstitial water, *Soil water, *Mass transfer, *Soil porosity, Soil structure, Model testing, Groundwater level, Hysteresis.

Mathematical modeling of various processes of heat and mass-transfer in soils and sediments is based mainly on phenomenological differential equations. One of the paths that is applicable to problems in heat and mass-transfer in soils is the imitation of the structure of the pore space of soils and sediments. A process by which a pore-space model, and hence the mathematical model, for mass-transfer may be chosen, was developed. This process includes the construction of a soil pore-space model, selecting mass-transfer equations for modeling the processes of interest, calculating the characteristics of the mass transfer equations from the model of the pore space, and testing the model in a physical experiment. An imitation model of moisture-transport in soils was formalized for cases of shallow and deep groundwater. The pore space is portrayed using a heuristic model consisting of transport pores and related dead-end pores. The model was able to describe hysteresis in moisture transport. (VerNooy-PTT)
W91-05352

CALCULATION OF MASS-EXCHANGE PROCESSES IN LEACHED SOILS.
Volga Inst. of Hydraulic Engineering and Melioration, Engel's (USSR).
T. K. Platonova, and Y. A. Pachepskiy.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 99-111, 1989. 3 fig, 3 tab, 27 ref. Translated from: Pochvovedeniye, No. 5, p 70-81, 1988.

Descriptors: *Mass exchange, *Leaching, *Soil chemistry, *Soil profile, *Ion exchange, Mathematical models, Soil solution, Mass transport, Ions, Model testing, Soil water, Soil structure, *Saline soils.

Mass-exchange processes, which control the transport of matter in soil solutions and the exchange of matter between the soil solution and other phases of the soil, play an important role in the functioning of the soil as a natural body. In the case of leaching of saline soils these processes occur very quickly and clearly. The major hypotheses used to describe mass-exchange processes in soils were analyzed. A detailed model of mass-exchange in the soil profile that would be suitable for solving practical problems in the prediction and optimization of leachings is proposed. The current state of this model (FAUST) is described, the first version of which was developed in 1981. In this model, the contents of several ions in the soil solution are examined (calcium(++), magnesium(++), sodium(+), hydrogen(+), chloride(-), sulfate(--), carbonate(--), bicarbonate(-), hydroxide(-)), as well as their ion pairs formed by these ions. It is shown that by sequential complication one can construct a complex model that takes into account the interaction of ions in soil solutions, cation-exchange, solution-precipitation of gypsum and carbonates, and the solution of carbon dioxide by soil air. Experimental data from leaching experiments under various conditions were examined. The model satisfactorily reproduces the redistribution of ions in leached soil profiles. (VerNooy-PTT)
W91-05353

MODELING OF MASS-EXCHANGE OF PHASES IN A SOLONETZIC SOIL LEACHED AFTER APPLICATION OF GYPSUM.
Akademiya Nauk SSSR, Moscow. Inst. of Soil Science and Photosynthesis.
K. Darab, M. Redli, Y. V. Mironenko, Y. A. Pachepskiy, and A. A. Ponizovskiy.
Soviet Soil Science SSSCAE, Vol. 21, No. 1, p 112-123, 1989. 3 fig, 2 tab, 35 ref. Translated from: Pochvovedeniye, No. 5, p 82-91, 1988.

Descriptors: *Mass exchange, *Leaching, *Soil chemistry, *Ion exchange, *Gypsum, *Soil treatment, Mathematical models, Model testing, Percolation rate, Soil water, Interstitial water, Diffusion, Dispersion, Thermodynamics, Salts, Soil solution, Mass transport.

The use of physical-chemical equations to describe mass-exchange equilibria in soils has made possible the construction of mathematical models that express the changes in soil composition during percolation of aqueous solutions. A mathematical model was constructed that describes the change in the composition of soil phases under the influence of soil-moisture (pore-solution) movement, molecular diffusion, hydrodynamic dispersion, ion-exchange, dissolution-precipitation of gypsum and calcite, and interaction of the pore solution with carbon dioxide of the soil air. The model is based on thermodynamic equations of mass-exchange of soil phases and equations for ion pairs used to calculate activities of ions in solution. The model was tested with data from an experiment using columns of a Solonetzic soil that was leached after application of gypsum. It is shown that to make the calculations agree well with the experimental data one must input constants from effective solubility of salts and isotherms of effective ion exchange; these are obtained from experiments carried out directly on the soils studied. (Author's abstract)
W91-05354

PERMEABILITY ANISOTROPY OF NATURAL CLAYS AS A FUNCTION OF STRAIN.
Laval Univ., Quebec. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W91-05359

LABORATORY MODELLING OF FIELD PERMEABILITY TESTS IN CASED BOREHOLES.
École Polytechnique, Montreal (Quebec).
For primary bibliographic entry see Field 2F.
W91-05363

LABORATORY STUDY ON LEACHING OF CALCAREOUS SOIL FROM KUWAIT.
Kuwait Univ., Safat. Dept. of Civil Engineering.
H. Al-Sanad, and B. Al-Bader.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 12, p 1797-1809, 1990. 10 fig, 3 tab, 12 ref.

Descriptors: *Leaching, *Kuwait, *Calcareous soils, *Dewatering, Salts, Cements, *Groundwater level, Irrigation, Pumping, Soil texture, Soil density, Flow rates, Groundwater movement, Brackish water, Soil strength, Pore size, *Irrigation effects.

The country of Kuwait has experienced a rise in the groundwater level in the past three decades, due to excessive irrigation in newly developed areas. Groundwater rise has resulted in an increased need for dewatering to lower the water table for construction of new basements, placement of utilities, and drainage of existing subsurface structures. Due to the calcareous nature of Kuwaiti soils, there is a concern that long-term pumping of groundwater may result in the migration of fines and washing-out of cementitious salts, leading to a possible reduction in soil strength. A laboratory investigation was initiated to understand the process of leaching of cementing salts and to study the factors controlling it. Leaching was found to be directly proportional to both soil density and percentage of fines. The flow rate had an insignificant effect, although brackish water had slightly less leaching capability than distilled water. Throughout the testing program the leaching process became essentially complete after a volume of water equivalent to approximately 3.5 times the pore volume passed through the soil. (Fish-PTT)
W91-05378

ESTIMATION OF ORGANIC CHEMICAL SORPTION BY SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
For primary bibliographic entry see Field 5B.
W91-05416

VOLATILIZATION OF ORGANIC COMPOUNDS IN UNSATURATED POROUS MEDIA DURING INFILTRATION.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
For primary bibliographic entry see Field 5B.
W91-05418

ORGANIC CARBON ISOTOPE GEOCHEMISTRY OF CLAYEY DEPOSITS AND THEIR ASSOCIATED POREWATERS, SOUTHERN ALBERTA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
L. I. Wassenaar, M. J. Hendry, R. Aravena, and P. Fritz.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 251-270, December 1990. 7 fig, 4 tab, 44 ref.

Descriptors: *Alberta, *Geochemistry, *Interstitial water, *Organic carbon, *Organic matter, *Sediments, Canada, Carbon dioxide, Carbon radioisotopes, Dissolved organic carbon, Environmental chemistry, Glacial soils, Till.

The organic carbon cycle of slowly permeable, clayey glacial till deposits in the Western Interior Great Plains, southern Alberta, was investigated by examining the relationship between solid organic matter (SOM) in the till sediments and dissolved organic carbon (DOC) in the till pore waters. Geochemically, the tills can be divided into two distinct zones: an upper oxidized (low SOM) till zone, and a lower unoxidized (high SOM) till zone. Till pore waters in both zones are characterized by high DOC contents. Radiocarbon dating and comparison of SOM and DOC fractions suggest DOC in the deep unoxidized zone originated during deglaciation, and is probably representative of groundwater ages in this till zone. In the oxidized zone, DOC originates from variable mixtures of soluble organic matter emplaced during deglaciation, and Cretaceous age coal fragments in this till zone. SOM in the upper till zone was mainly oxidized to CO2 gas during lowered water table conditions of the Altithermal climatic period. The subsurface production of fossil CO2 gas has serious implications for using the conventional dissolved inorganic carbon (DIC) 14-C groundwater dating method in these clayey till porewaters. (Author's abstract)
W91-05441

WATER AND SOLUTE MOVEMENT IN A COARSE-TEXTURED WATER-REPELLENT FIELD SOIL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Hydraulics and Catchment Hydrology.
J. C. Van Dam, J. M. H. Hendrickx, H. C. Van Ommen, M. H. Bannink, and M. T. Van Genuchten.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 359-379, December 1990. 8 fig, 6 tab, 42 ref.

Descriptors: *Infiltration, *Soil texture, *Soil water, *Solute transport, *Water repellent soils, Bromides, Clays, Convection, Dispersion, Ficks Law, Flow profiles, Hydraulic conductivity, Mathematical models, Organic matter, Richards equation, Soil properties, The Netherlands.

Unstable water flow in water-repellent unsaturated soils can significantly affect the processes of infiltration and soil water redistribution. A field experiment was carried out to study the effect of water-repellency on water and bromide movement in a coarse-textured soil in the southwestern part of The Netherlands. The field data were analyzed using a relatively simple numerical model based on the standard Richards' equation for unsaturated water flow and the Fickian-based convection-dispersion equation for solute transport. Water repellency was accounted for by multiplying the water content and the unsaturated hydraulic conductivity of the soil with F, a factor equal to the volumetric fraction of soil occupied by preferential flow paths resulting from the unstable flow process. The good comparison of simulated and measured bromide concentrations suggests that the model provides a viable method for simulating unstable water flow in water repellent soils. (Author's abstract)
W91-05448

FRACTIONATION OF THE ORGANIC MATTER IN SOILS AND SEDIMENTS AND THEIR CONTRIBUTION TO THE SORPTION OF PESTICIDES.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
For primary bibliographic entry see Field 5B.
W91-05466

SOIL CONTROLS ON RECHARGE TO AQUIFERS.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W91-05469

COMPARISON OF THE SURFACE IMPEDANCE FACTORS OF CA, NA, RB, AND CS DERIVED FROM THEIR SELF-DIFFUSION COEFFICIENTS IN VARIOUS SOILS.
Oxford Univ. (England). Soil Science Lab.
For primary bibliographic entry see Field 5B.
W91-05471

EFFECT OF IRRIGATION SCHEDULE ON SOIL TEMPERATURE.
Indian Inst. of Tech., Kharagpur. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-05476

EFFECT OF POLYVINYL ALCOHOL, DEXTRAN AND HUMIC ACID ON SOME PHYSICAL PROPERTIES OF A CLAY AND LOAM SOIL: I. CRACKING AND AGGREGATE STABILITY.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
D. K. Painuli, and M. Pagliai.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 117-130, 1990. 7 fig, 3 tab, 15 ref.

Descriptors: *Aggregates, *Clays, *Humic acids, *Italy, *Loam, *Organic conditioners, *Soil amendments, *Soil structure, *Soils, Agriculture, Cracks, Irrigation, Precipitation.

The effectiveness of three organic conditioners in improving the structure of two different intensively cultivated soils from the Tyrrhenian coast were evaluated. The soils, a clay and a loam, were selected for the study because they have recently exhibited various structure-related problems, such as: extremely slow infiltration; rain and irrigation water becomes impounded creating an aeration problem; drying produces large cracks; seed bed preparation requires considerable effort and surface sealing and crusting are also common. Laboratory studies were carried out to examine the effects of polyvinyl alcohol, dextran and humic acid added at rates of 0, 0.5, 1.0 and 2.5% by mass, on structure modification of the two soils. Results showed that both polyvinyl alcohol and dextran improved the soil structure with the following conditions: cracks were more numerous, thinner and longer; clods were smaller; water dispersible silt-plus-clay was less; and mean weight diameter was the same (Polyvinyl alcohol) or less (Dextran) than in the control samples. Humic acid, especially in the clay soil, did not have such favorable effects. In fact it appeared to cause the formation of a few large cracks and consequently bigger clods. The water dispersible silt-plus-clay was higher for humus than in the control samples. It was concluded that polyvinyl alcohol and dextran could be

used to favorably improve a soil structural environment for the examined soils. (See also W91-05481) (Agostine-PTT)
W91-05480

EFFECT OF POLYVINYL ALCOHOL, DEXTRAN AND HUMIC ACID ON SOME PHYSICAL PROPERTIES OF A CLAY AND LOAM SOIL: II. HYDRAULIC CONDUCTIVITY AND POROSITY.

Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
D. K. Painuli, M. Pagliai, M. La Marca, and G. Lucamante.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 131146, 1990. 5 fig, 3 tab, 28 ref.

Descriptors: *Clays, *Humic acids, *Hydraulic conductivity, *Loam, *Organic conditioners, *Soil amendments, *Soil porosity, *Soil structure, *Soils, Soil moisture retention.

Laboratory studies were carried out on a clay and loam soil to evaluate the modification in saturated hydraulic conductivity and in soil porosity induced by polyvinyl alcohol (PVA), dextran (D) and humic acid (HA). Porosity was measured on soil thin sections by image analysis (Quantimet 720) and its relationship with hydraulic conductivity was studied by percolating 0.1% methylene blue solution that colored the walls of pores in which the solution flowed. The saturated hydraulic conductivity was higher in samples treated with PVA and D than in the control samples, while in samples treated with HA the hydraulic conductivity decreased with respect to the control samples. The porosity data showed that the hydraulic conductivity was positively related to the proportion of elongated 'transmission' pores in the range 50-500 micrometers. Therefore the PVA seemed to be the most efficacious in improving the continuity of the pore system in the soil. Moreover it was found that PVA and D increased the water retention against gravity. It is possible to conclude that adding PVA and D to soils can improve such physical properties of the soil as hydraulic conductivity, water retention, porosity and the overall pore shape, pore size distribution and pore continuity. The HA as used in this experiment did not seem to induce these positive modifications. (See also W91-05480) (Author's abstract)
W91-05481

ABSORPTION OF HERBICIDES BY SOILS OF THE CAMPANIA REGION (ADSORBIMENTO DI DISERBANTI SU SUOLI DELLA CAMPANIA).

Naples Univ. (Italy). Ist. di Chimica Agraria.
For primary bibliographic entry see Field 5B.
W91-05482

ALTERNATIVE METHODS OF ESTIMATING WATER DEFICIT STRESS OF WHEAT GROWN ON UNDISTURBED AND REPACKED SOIL IN DRAINAGE LYSIMETERS.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2I.
W91-05494

DEVELOPMENT OF A MICROBIAL COMMUNITY ON CELLULOSE BURIED IN WATERLOGGED SOIL.

Tokyo Univ. (Japan). Dept. of Agricultural Chemistry.
M. Saito, H. Wada, and Y. Takai.
Biology and Fertility of Soils BFSOEE, Vol. 9, No. 4, p 301-305, 1990. 4 fig, 1 tab, 26 ref.

Descriptors: *Biodegradation, *Cellulose, *Excess water, *Microbiological studies, *Microorganisms, *Nutrients, *Rice, *Soil organisms, *Soil water, *Succession, *Waterlogging, Biomass, Ecosystems, Metabolites, Nitrogen, Soil environment.

The development of a microbial community on cellulose (cellophane film and filter paper) buried in waterlogged soil was observed under a microscope. The cellulose sheets were buried in two waterlogged soils, and the microbial processes in the micro-subsystems surrounding these substrates were investigated throughout the decomposition of the cellulose, thorugh examinations of the biomass, immobilized N, ATP, and gas metabolism of the microbial community. As cellulose decomposition progressed, a microbial succession was recognized, which could be divided into two stages. In the first stage, a few types of cellulolytic microorganisms predominated on the cellulose, vigorous decomposition of the cellulose was accompanied by a rapid increase in microbial biomass, and H2 was evolved from the microbial community on the cellulose. In the second stage, the rate of cellulose decomposition was slow and the cellulose remaining was thickly covered with various types of microorganisms. The H2 produced in this second stage was consumed by the microorganisms closely adhering to the remaining cellulose. In addition, non-cellular organic nitrogen accumulated on the remaining cellulose. A large number of microorganisms seemed to be dormant in this stage. The trends of this microbial succession were similar to those found in ecosystem successions, which are characterized by an increase in both the complexity of community structure and the diversity of niches, and by the development of a closed nutrient cycle. (Author's abstract)
W91-05555

SOIL WATER EFFECTS ON THE USE OF HEAT UNITS TO PREDICT CROP RESIDUE CARBON AND NITROGEN MINERALIZATION.

Agricultural Research Service, Orono, ME. New England Plant, Soil and Water Lab.
D. S. Doel, C. W. Honeycutt, and W. A. Halteman.
Biology and Fertility of Soils BFSOEE, Vol. 10, No. 2, p 102-106, 1990. 3 fig, 3 tab, 31 ref.

Descriptors: *Carbon, *Crops, *Environmental chemistry, *Mineralization, *Nitrogen, *Nutrients, *Soil chemistry, *Soil water, Agriculture, Enthalpy, Field tests, Industrial wastes, Mathematical studies, Probabilistic process, Soil amendments, Soil properties.

Soil heat units (degree days) have previously been shown to predict net N mineralization from crop residues and papermill sludge. The effects of soil water potential on predictions of mineralization with heat units were identified and compared to field results of white lupin (Lupinus albus L. cv. 'Ultra') N mineralization. Lupin amended soil and unamended controls were incubated at factorial combinations of temperature (15, 20, and 25 C) and soil moisture (-0.30, -0.03, and -0.01 MPa) for 198 days. Incorporation of the lupin residue resulted in net N immobilization. No net N mineralization had been observed for any temperature at a soil moisture level of -0.30 MPa by the close of the incubation study. The number of heat units that accumulated until commencement of net N mineralization did not differ for five of the six remaining temperature-water treatment combinations. The number of heat units that accumulated until net N mineralization began (2058-2814 degree-days) in the present study were similar to those reported in a complementary field study (1990-2360 degree-days). Temperature and moisture interactively affected lupin-residue C mineralization. The cumulative substrate C that had evolved by the time of net N mineralization did not differ for a give temperature between soil moisture levels of -0.03 and 0.01 MPa. Heat units appear to adequately predict net N mineralization from organic residues at soil water potentials within the -0.03 to -0.01 MPa range, but may not be valid for prolonged drier conditions. (Author's abstract)
W91-05556

FIELD EVALUATION OF TISSUE CULTURE DERIVED SORGHUM FOR INCREASED TOLERANCE TO ACID SOILS AND DROUGHT STRESS.

Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 2I.
W91-05558

CHLORIDE ANALYSES OF SOIL LEACHATE USING THE TRAACS 800 ANALYZER.

Guelph Univ. (Ontario).
For primary bibliographic entry see Field 5A.
W91-05560

VARIATIONS IN CHEMICAL COMPOSITION OF THE SOIL SOLUTION OVER A FOUR-YEAR PERIOD AT AN UPLAND SITE IN SOUTHWEST SCOTLAND.

Stirling Univ. (Scotland). Dept. of Environmental Science.
I. C. Grieve.
Geoderma GEDMAB, Vol. 46, No. 4, p 351-362, June 1990. 4 fig, 3 tab, 22.

Descriptors: *Acid rain effects, *Environmental chemistry, *Field tests, *Geochemistry, *Scotland, *Soil chemistry, *Soil solution, Chemical analysis, Dissolved organic carbon, Hydrogen ion concentration, Ions, Moisture meters, Peat soils, Precipitation, Seasonal variation, Soil properties.

Variations on soil solution chemical composition were monitored over a period of almost four years in a peaty soil in the Loch Dee catchment, southwest Scotland. Samplers were arranged on a transect down a 100 m length of slope. Five suction-free lysimeters collected soil solution draining from the uppermost 20 cm of soil and seven porous pot suction lysimeters collected solution from 50-60 cm (subsequently referred to as 60 cm). Soil solutions were spatially variable in their composition, but within-plot coefficients of variation were similar to those for soil properties. Soil solutions were acidic with a mean pH (4.2 at surface 20 cm and 4.7 at 60 cm) lower than that of rainfall. Exchange of H(+) ions for Ca accounted for most of the increase in pH with depth. Annual cycles in solution concentrations were identified, with winter peaks in Cl, Na and Mg, and a late summer peak in dissolved organic carbon (DOC) and Fe. Winter maxima in precipitation derived ions can be related to input variations. Summer maxima in organic-related constituents had a less well defined relationship with temperature and flushing. DOC was highly correlated with Fe, and less highly with Al, and contributed to the overall ionic balance. pH was also significant in Al mobilization, with winter Al peaks and high proportions of labile Al at this time. Concentrations of calcium at both 20 and 60 cm and sodium and magnesium at 60 cm showed little variation. (Agostine-PTT)
W91-05564

HYDRAULIC CONDUCTIVITY AND LEACHING OF AN ORGANIC SALINE-SODIC SOIL.

Agricultural Coll. of Athens (Greece). Lab. of Soils and Agricultural Chemistry.
C. Kosmas, and N. Moustakas.
Geoderma GEDMAB, Vol. 46, No. 4, p 363-370, June 1990. 3 fig, 2 tab, 20 ref.

Descriptors: *Hydraulic conductivity, *Irrigation effects, *Leaching, *Organic soils, *Saline soils, *Soil structure, *Soil water, Clays, Groundwater movement, Interstitial water, Loam, Organic matter, Percolation, Soil properties, Statistical analysis, Water.

The hydraulic conductivity of an organic saline-sodic soil was measured as a function of the organic matter content, dry material, pH, total iron oxides, clay content and optical density of the leachate in a soil column. Changes in sodium concentration of the percolating water along the soil column were also recorded. The calcerous organic soil used in this study was a clay loam Fluvaquentic Medisaprist. The parent material was organic lacustrine deposits which characterized the soil as saline-sodic. Hydraulic conductivity initially increased with the increasing volume of leachate until a maximum value which coincided with the maximum of the total dry material in the leachate. As the volume of the leachate increased, the hydraulic conductivity decreased to a minimum value which coincided with a maximum of the total organic matter content and the optical density of the leachate. Data show that plugging of pores by dispersed organic and clay particles was the main

cause of reduced hydraulic conductivity, while dissolution of organic substances was the major cause for increased hydraulic conductivity. Salt concentration increased with soil column depth first in an exponential and later in a double linear relationship until an almost steady state appeared in the whole soil column. (Agostine-PTT)
W91-05565

MINERALOGICAL IMPLICATIONS OF HIGH RATIOS OF 1500 KPA WATER CONTENT TO PERCENT MEASURED CLAY FOR TWO SOILS OF WESTERN NEBRASKA.
Nebraska Univ.-Lincoln. Dept. of Agronomy.
N. B. Stolpe, and D. T. Lewis.
Geoderma GEDMAB, Vol. 47, No. 1/2, p 1-16, August 1990. 4 fig, 10 tab, 36 ref.

Descriptors: *Clays, *Mineralogy, *Soil chemistry, *Soil water, *Water chemistry, Allophane, Cations, Elemental analysis, Glass, Minerals, Nebraska, Soil properties.

Tripp (coarse-silty, mixed, mesic Aridic Haplustolls), and Mitchell (coarse-silty, mixed (calcerous), mesic Ustic Torriorthents) soils of western Nebraska have frequently exhibited high ratios of 1500 kPa water content to percent measured clay. Both soils were known to contain considerable amounts of volcanic glass. Two hypotheses were formulated: (1) the 1500 kPa water to percent measured clay ratios are being positively influenced by the presence of mineral allophane in the soils; and (2) the ratios are being positively influenced by the presence of nondispersing montmorillonite coatings in the sand and silt fractions of the soils. Experiments were conducted to determine if the anomalous ratios were related to the presence of volcanic glass or associated minerals. Allophane was not present as determined by differential scanning calorimetry, thermal gravimetric analysis, elemental analysis of acid-oxalate extractions, or pH dependent cationic exchange capacity. The separate particle size fractions were analyzed using X-ray diffraction (oriented mounts), scanning electron microscopy, optical mineralogy, and tested for cationic exchange capacity (CEC) and specific surface. It was concluded that the high ratios of 1500 kPa water to percent measured clay were not caused by allophane, but rather by the presence of nondispersing smectic coatings in the sand and silt fractions of the Tripp and Mitchell soils. The clay coatings in these fractions were not measured as clay during particle size analysis, but they influenced CEC, specific surface, 1500 kPa water content, and therefore influenced the respective ratio values. (Agostine-PTT)
W91-05567

LOCAL DIFFERENCES IN SOIL TEMPERATURE AND SOIL MOISTURE REGIMES ON A MOUNTAIN SLOPE, HAWAII.
Hawaii Univ., Honolulu. Dept. of Geography.
D. Nullet, H. Ikawa, and P. Kilham.
Geoderma GEDMAB, Vol. 47, No. 1/2, p 171-184, August 1990. 8 fig, 3 tab, 14 ref. U.S. Dept. of Agriculture Special Grants Program in Tropical and Subtropical Agriculture 83-CRSR-2-2088 and 59-9AHZ-2-669.

Descriptors: *Hawaii, *Hydrologic budget, *Mountains, *Soil temperature, *Soil water, Climatic data, Orography, Precipitation, Rainfall, Seasonal variation, Soil properties.

Soil temperature and soil moisture data collected over a five-year period on the northwest slope of Haleakala, a mountain on the island of Hawaii, was analyzed. The data is from a climate monitoring network that has been maintained on the northwestern flank of the mountain since mid-1983 and which supports various local and international research projects. The study site covers approximately 400 sq km and the spacing between adjacent stations ranges from a few hundred meters to seven kilometers. Station elevations range from 40 to 1650 meters. Soil temperature regimes over the study area indicate that the isothermic zone extends higher on the mountain than previously thought and that the dry leeward areas contain a hyperthermic zone. Hyperthermic regimes had not previously been identified in the Hawaiian Islands. Soil moisture regimes range from aridic to udic. The hyperthermic-isohyperthermic boundary and the limit of the aridic regime coincide approximately with the isohyet of 600 mm annual rainfall, an amount close to the average annual rainfall of the nearby open ocean. In general, the diversity shown here is a product of differences in elevation and in rainfall. The rainfall gradients in turn are a product of orographic effects under the prevailing winds. (Agostine-PTT)
W91-05569

CHEMICAL RECLAMATION OF SALINE-SODIC SOILS OF THE LOWER DON FLOODPLAIN BY SOME INDUSTRIAL WASTES.
Moscow State Univ. (USSR). Dept. of Soil Science.
D. S. Orlov, I. A. Luganskaya, and I. N. Lozanovskaya.
Soviet Soil Science SSSCAE, Vol. 21, No. 3, p 78-89, 1989. 2 fig, 3 tab, 39 ref. Translated from: Pochrovedeniye, 1988, 12:10-20.

Descriptors: *Cleanup operations, *Industrial wastes, *Land disposal, *Saline soils, *Soil amendments, *Soil chemistry, *Soil contamination, *USSR, Aggregates, Copper compounds, Field tests, Gypsum, Soil management, Waste disposal.

The predominant chemical reactions in soils during the reclamation of Solonetzes by gypsum, phosphogypsum, sulfuric acid and iron sulfate were studied both in the laboratory and in the field. Field trials were conducted at the 'Yelkinskiy' sovkhoz of Rostov Oblast to study the effect of applying half an application and the full calculated amount of phosphogypsum and copperas (green ferrous sulfate heptahydrate), as well as a 1:1 mixture of the two. The studies were conducted on 21 sq m plots over a period of three years. Calculations of the amounts of amendments for a soil layer 20 cm thick were based on the amount of exchangeable sodium in the adsorption complex. Results show that phosphogypsum and copperas reduce the content of adsorbed sodium, lower the activity of sodium ions in soil suspensions and contribute to the enrichment of the soil in calcium. During the third year of reclamation the decrease in pH values and alkalinity was pronounced. As a result of reclamation the content of water-peptizable clay was reduced and the aggregate status of the soils improved. In pot tests it was found that the tops and roots of barley increased two to three-fold upon growth on reclaimed soil. To improve saline-sodic soils of the lower Don floodplain a mixture of phosphogypsum and copperas in the full calculated amount is recommended. Large tonnages of titanium dioxide production wastes are suitable for this purpose. (Agostine-PTT)
W91-05576

WATER-DROP KINETIC EFFECT ON WATER INFILTRATION IN CALCIUM AND MAGNESIUM SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
R. Keren.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1624-1628, November/December 1989. 7 fig, 1 tab, 26 ref. BARD grant No. I-743-84.

Descriptors: *Calcium, *Infiltration, *Magnesium, *Rainfall impact, *Rainfall infiltration, *Soil water, *Surface sealing, Aggregates, Calcium carbonate, Clays, Dispersion, Electrolytes, Kinetic energy, Saturated soils, Simulated rainfall, Soil types.

The effect of adsorbed magnesium and calcium ions on the infiltration rate (IR) of two montmorillonitic soils (Calcic Haploxeralf and Typic Rhodoxeralf) was studied at several kinetic energies of water drops. The kinetic energy of the water drops, the type of adsorbed ion and the electrolyte concentrations in the applied solution all have a strong effect on the IR of the soils saturated by Mg or Ca ions. The higher IR values of the soils exposed to electrolyte solution suggests that clay dispersion takes place in magnesium and calcium soils exposed to deionized water from simulated rainfall. The IR of the soils decreased with increasing kinetic energy and the values were always lower for magnesium soils than for calcium soils. This difference was attributed to the higher width of the hydration shell of the adsorbed magnesium than the calcium ion. Breakdown of the soil aggregates and clay dispersion are the two mechanisms that appear to be operative in seal formation when soils are saturated by either calcium or magnesium ions exposed to deionized water. Magnesium adsorbed by montmorillonite soils has a specific effect on IR, whether the soils contain calcium carbonate or not. (Author's abstract)
W91-05598

MECHANISM OF WATER ENTRY INTO SIMULATED MACROPORES.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
P. E. Phillips, V. L. Quisenberry, J. M. Zeleznik, and G. H. Dunn.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1629-1635, November/December 1989. 3 fig, 3 tab, 14 ref.

Descriptors: *Infiltration, *Saturated soils, *Soil porosity, *Soil water, Fluctuations, Laboratory methods, Macropores, Manometers, Water pressure.

When soil is unsaturated, water cannot enter soil macropores that begin below the soil surface. Water under negative pressure can enter simulated macropores, after first establishing a continuous water film on the full length of the macropore walls. The simulated macropores were hollow, cylindrical, straight-walled glass tubes 4.88, 2.60, and 0.85 mm in diameter. Water flux through the simulated macropores was obtained down to a negative water pressure of minus 1.02 kPa, by placing simulated macropores against a porous fritted-glass plate 60 mm in diameter with pore diameters between 40 and 60 microm after establishing a water film on the walls of the simulated macropores. The flux of water down the simulated macropores varied from 0 to 67 cubic mm/sec depending on the contact of the simulated macropore with the porous plate, which influenced the continuity of water in the porous plate with water films on the walls of the simulated macropores. A water manometer was connected to the bubbler of the burette in order to measure the total negative water pressure operating in the simulated macropores. The total negative water pressure operating in the simulated macropores was equal to the sum of the negative water pressure due to the difference in elevation of water menisci of the water manometer and the matrix potential in the pores of the fritted-glass plate. (Author's abstract)
W91-05599

USING BREAKTHROUGH CURVES FOR PARAMETER ESTIMATION IN THE CONVECTION-DISPERSION MODEL OF SOLUTE TRANSPORT.
Hiroshima Univ. (Japan). Dept. of Environmental Science.
T. Yamaguchi, P. Moldrup, and S. Yokosi.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1635-1641, November/December 1989. 6 fig, 3 tab, 12 ref.

Descriptors: *Convection, *Dispersion, *Mathematical models, *Model studies, *Soil water, *Solute transport, *Wastewater renovation, Hydrodynamics, Parameter estimation, Saturated flow, Unsaturated flow, Variation coefficient.

Transport phenomena of solutes through soils are significant processes in both crop production and wastewater renovation. Two easily applicable models were developed for the simultaneous estimation of the solute-transport parameters, convective velocity (u) and the hydrodynamic dispersion coefficient (D) from breakthrough curve (BTC) data. The two models can be used for both saturated and unsaturated flow. Both models are derived from an analytical solution to the convection-dispersion equation (CDE). The first model, labeled the slope method, is exact, using the slope of the

BTC to estimate u and D. The second method is approximate, based only on the first term of the analytical solution to the CDE. This model is labeled the first-term method and is not valid for very small values of Brenner number. The simple version of the slope method is found to be too numerically unstable when applied to actual BTC data. The remaining methods were tested against two sets of actual measured BTC data by applying each method several times for different parts of each BTC. The values of coefficient of variation between the results are low for all methods (0.1 to 1.3% for u and 2.7 to 32% for D). The agreement between the mean values of the parameters u and D obtained by using these methods and the parameter values for the same BTC data sets reported by other authors is excellent. (Brunone-PTT)
W91-05600

PHOSPHORUS BEHAVIOR IN FLOODED-DRAINED SOILS: I. EFFECTS ON PHOSPHORUS SORPTION.
California Univ., Davis. Dept. of Agronomy and Range Science.
R. N. Sah, and D. S. Mikkelsen.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1718-1722, November/December 1989. 4 fig, 2 tab, 28 ref.

Descriptors: *Drainage, *Flooding, *Irrigation, *Nutrient transport, *Phosphorus, *Soil physical properties, *Soil water, *Sorption, California, Iron, Laboratory methods, Nutrient concentrations, Organic matter, Temperature effects.

The effects of flooding periods (FP), organic matter (OM) addition, and temperature changes are examined during soil flooding on phosphorus sorption in 10 flooded-drained (FD) California soils. The soils were flooded for 0 to 90 days, drained, air dried, and used for phosphorus sorption studies at six (0.3 to 2.0 mM) initial phosphorus concentrations. Four soils, showing a wide variation in phosphorus sorption capacity, were evaluated for the effects of OM and temperature treatments. Using phosphorus sorption isotherms, a relationship between phosphorus sorption and FP was developed for a given final phosphorus concentration for each soil. Flooding soil without added OM increased phosphorus sorption by 10 to 70% in half of the 10 soils. Organic matter treatment and elevated temperature during flooding further increased phosphorus sorption and shortened the FP at which phosphorus sorption reached maxima. The soils in which phosphorus sorption did not increase without OM treatment were low in either OM or reducible iron. The largest increase in phosphorus sorption as a result of OM and temperature treatments was found in a soil that had low OM but a high level of reducible iron. These findings suggest that OM and temperature are important factors determining the impact of FD conditions on phosphorus sorption. (See also W91-05603 and W91-05604) (Author's abstract)
W91-05602

PHOSPHORUS BEHAVIOR IN FLOODED-DRAINED SOILS. II. IRON TRANSFORMATION AND PHOSPHORUS SORPTION.
California Univ., Davis. Dept. of Agronomy and Range Science.
R. N. Sah, D. S. Mikkelsen, and A. A. Hafez.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1723-1729, November/December 1989. 6 fig, 2 tab, 29 ref.

Descriptors: *Drainage, *Flooding, *Iron, *Irrigation, *Nutrient transport, *Phosphorus, *Soil physical properties, *Soil water, *Sorption, Laboratory methods, Organic matter, Separation techniques, Soil chemistry, Temperature effects.

Effects of flooding periods (FP), organic matter (OM) and temperature treatments during flooding on iron transformation in flooded-drained (FD) soils were studied on four soils representing wide variations in the effect of FD conditions on phosphorus activity. The soils were extracted in sequence with ammonium oxalate at pH 6 (amorphous FeA) and at pH 3 (amorphous FeB), and with dithionite-citrate-bicarbonate reagent (free iron oxides). The amorphous FeA fraction increased with FP, OM treatment, and elevated temperature. In soils with low amorphous-iron to free-iron-oxide ratio, both amorphous FeA and free iron oxides increased at the expense of amorphous FeB as the FP increased. In soils with low amorphous-iron to free-iron-oxide ratio, both amorphous iron fractions (A and B) increased at the expense of free iron oxides as FP increased. For all soils, the iron transformation during soil flooding was accelerated by OM and high-temperature treatments, both of which contributed to an increased redox potential in the soil. Amorphous FeA fraction correlated well with phosphorus sorption under all combinations of OM and temperature in each soil, while other iron fractions correlated well only under certain conditions. Results suggest that the nature and the magnitude of iron transformations in these FD soils depend on interacting effects of FP, OM, and temperature. (See also W91-05602 and W91-05604) (Author's abstract)
W91-05603

PHOSPHORUS BEHAVIOR IN FLOODED-DRAINED SOILS: III. PHOSPHORUS DESCRIPTION AND AVAILABILITY.
California Univ., Davis. Dept. of Agronomy and Range Science.
R. N. Sah, D. S. Mikkelsen, and A. A. Hafez.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1729-1732, November/December 1989. 4 fig, 2 tab, 30 ref.

Descriptors: *Drainage, *Flooding, *Irrigation, *Nutrient availability, *Nutrient transport, *Phosphorus, *Soil physical properties, *Soil water, *Sorption, California, Corn, Fertilizers, Organic matter, Soil chemistry, Temperature effects.

Four California soils that showed wide variability in soil properties and phosphorus sorptivity under flooded-drained (FD) conditions were studied. The soils were flooded for 0 to 90 days at two levels of organic matter (OM, 0 and 10 g/kg) and two temperatures (23 and 35 C). The soils were subsequently drained and used for phosphorus-sorption studies at 0.3, 1.2, and 2.0 mM initial phosphorus concentrations. The phosphorus desorption from phosphorus-sorbed soils were carried out in three consecutive extractions with 0.1 M sodium chloride. The effect of FD conditions on phosphorus availability to corn (Zea mays L.) was studied at three levels of phosphorus (0, 5, and 20 mg phosphorus/kg soil). Without OM treatment, FD conditions decreased phosphorus sorption in three of four soils examined. Added OM and higher temperature further decreased phosphorus desorption and the period of flooding required to reach the minimum phosphorus desorption. Organic matter markedly decreased phosphorus desorption even in the soil, which was unaffected by FD conditions. Under FD conditions, plant-tissue phosphorus concentration of corn was decreased to a variable extent depending on soil type. The desorption of added fertilizer phosphorus in a given FD soil correlated well with changes in the amorphous FeA fraction under comparable conditions. Phosphorus sorption and desorption were controlled by the changes in amorphous FeA and, in some cases, amorphous FeB fractions. (See also W91-05602 and W91-05604) (Author's abstract)
W91-05604

USE OF COLOR SPLITTING AND A COMPUTER TECHNIQUE TO SEPARATE SOIL MOISTURE GROUPS.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
S. R. Al-Abed, D. T. Lewis, and S. A. Samson.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1813-1818, November/December 1989. 2 fig, 4 tab, 16 ref.

Descriptors: *Colorimetry, *Computer programs, *Instrumentation, *Photography, *Soil water, Densitometers, Drainage, Filtration, Saturated soils, Separation techniques, Soil physical properties, Soil types.

A method to quantify the distribution of colors across the surface and interior of soil peds was developed and used on soils that differed in morphological indicators of soil drainage. Soils from two contrasting geomorphic settings were selected for study. In the first of these settings, morphological indicators have not appeared to be useful predictors of actual soil wetness. In the second setting, soil morphology appears to predict wetness reasonably well. Pedons in the second setting provided an independent set of data against which to evaluate judgements made about pedon wetness of the first geomorphic setting. Pedon morphology was determined and duration of saturation was measured for all pedons studied. Saturation measurements were used to place pedons studied in a wet, medium, or dry moisture group. Ped surfaces and interiors were photographed using a 35-mm camera and color slides were prepared. Color patterns on these slides were analyzed using a digital densitometer. Colors were separated through use of the corresponding filters. Densities of these colors on each slide were determined and ranked within six brightness subranges. Cluster analysis was used to group the color rankings. Groups formed through this procedure coincided with groups formed through measurement of duration of saturation. This procedure appeared to be better able to predict actual saturation than did commonly used methods based on horizon color and/or mottle features. The method provides the ability to remove subjectiveness from soil color measurements and to quantify the measurements of soil color. Its predictive value appears to equal or exceed that of commonly applied techniques. (Author's abstract)
W91-05605

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: I. SEEDLING GROWTH AFFECTED BY SOIL WATER POTENTIAL.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
A. Bouaziz, and L. Bruckler.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1832-1838, November/December 1989. 8 fig, 6 tab, 26 ref.

Descriptors: *Crop yield, *Model studies, *Plant growth, *Seedlings, *Soil water potential, *Soil-water-plant relationships, *Wheat, Mathematical models, Parameter estimation, Root elongation, Soil aggregates, Soil physical properties, Temperature effects.

To improve the prediction of wheat (Triticum aestivum L.) emergence, an empirical model of wheat root and shoot growth, which takes into account the soil water potential effects, was proposed. Pregerminated seeds from a Moroccan wheat cultivar, Nesma 149, were used for laboratory experiments at a constant 22 C temperature. Seminal root and shoot lengths were measured versus time using a completely randomized design, for a clay loam soil (33.6% clay, 57.0% loam and 19.4% sand) at five water potentials: negative 0.02, negative 0.17, negative 0.39, negative 1.0, negative 1.31 MPa. Soil dry bulk density of aggregates < or = 3 mm was 1000 kg/cubic m and thus, soil mechanical resistance to root growth was regarded as a nonlimiting factor. Data were used to select satisfactory growth functions for seminal root axes and shoots and to estimate their empirical parameters. The monomolecular and Gompertz functions were retained for roots and aerial parts, respectively. Considering that the soil water potential in the root zone controlled the root elongation rate, the average soil water potential was taken into account along the root axes for calculations. Furthermore, the effects of soil water potential on the estimated parameters of the models involved in the growth models were studied. Results showed that roots and shoots responded differently to soil water stress. After 17 days, total root lengths varied from approximately 600 mm to 300 mm for the negative 0.02 MPa and negative 1.31 MPa treatments, respectively, whereas shoot lengths were similar. The growth curves calculated with soil water potential as input were compared with observed results. The correlation coefficient between predicted and observed data varied from 0.77 to 1.00. (See also W91-05608) (Author's abstract)
W91-05607

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: II. COMPARISON WITH FIELD EXPERIMENTS.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
For primary bibliographic entry see Field 2I.
W91-05608

EARTHWORM EFFECTS ON CORN RESIDUE BREAKDOWN AND INFILTRATION.
Minnesota Univ., St. Paul. Dept. of Soil Science.
J. E. Zachmann, and D. R. Linden.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1846-1849, November/December 1989. 1 fig, 2 tab, 16 ref.

Descriptors: *Infiltration, *Oligochaetes, *Soil chemistry, *Soil water, Biodegradation, Decomposition, Diurnal variation, Laboratory methods, Simulated rainfall, Temperature effects, Tillage.

Earthworm (Lumbricus rubellus hoffmeister) activity in the field has been implicated in increased rates of residue turnover, surface soil stabilization, and increased infiltration rates due to macroporous flow. A growth-chamber study was conducted to evaluate some of the field variables associated with L. rubellus activity and tillage systems. Polyethylene buckets packed with sieved soil had either surface-applied, incorporated, or no corn (Zea mays) residue, each with or without worms. Treatments were subjected to diurnal temperature and light sequences, and periodic additions of water were made over 60 days to maintain near-optimum moisture conditions. Corn was grown in the cultures for an additional 30 days and was harvested before a small amount of concentrated Br solution was sprayed on the soil surface. Cultures were then subjected to simulated rainfall. Corn residue in the surface-residue treatment with worms degraded 30% faster than in the no-worm control. Plant growth and nitrogen content were not affected by the presence of worms. Burrows and casts formed under surface residue were greater in number and stability than in other worm/residue combinations. The surface-residue treatment with worms reduced runoff and caused incoming water to bypass the surface soil matrix, moving small quantities of Br to significantly greater depths than in other treatments. Depth of peak Br concentration was greater in no-residue treatments than in surface-residue/worm or incorporated-residue/worm or no-worm treatments, indicating a substantial difference in the displacement of surface-applied Br during rainfall. L. rubellus may alter the water balance of field soils while simultaneously hastening decomposition of the residue mat. (Author's abstract)
W91-05609

COTTON ROOT GROWTH AND SOIL WATER EXTRACTION.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
For primary bibliographic entry see Field 2I.
W91-05610

RAINFALL-SOIL MOISTURE RELATIONS IN LANDSLIDE-PRONE AREAS OF A TROPICAL RAIN FOREST, PUERTO RICO.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 2A.
W91-05624

SOLUTE REJECTION IN FREEZING SOILS.
HydroGeoLogic, Inc., Herndon, VA.
For primary bibliographic entry see Field 2K.
W91-05840

HILLSLOPE INFILTRATION: PLANAR SLOPES.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
J. R. Philip.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 109-117, January 1991. 7 fig, 1 tab, 17 ref.

Descriptors: *Infiltration, *Mathematical analysis, *Slopes, *Soil water, *Subsurface flow, *Unsaturated flow, Anisotropy, Capillarity, Gravity, Hydrologic models, Mathematical equations, Temporal distribution.

How surface flow affects the dynamics of infiltration into a hillslope (i.e., normal to the slope) and the nature of the downslope (i.e., parallel to the slope) subsurface, essentially unsaturated, flow are two important questions in the hydrology of hillslopes. The solution of the full nonlinear unsaturated flow equation is presented for the problem of infiltration and associated subsurface flows into a planar hillslope of homogeneous isotropic soil with uniform initial moisture content. The solution uses the assumption that, at some distance below the slope crest, a spatial equilibrium is approached with the moisture content (and other properties) independent of the downslope coordinate and dependent only on the normal coordinate and time (t). The analysis is generally applicable beyond a small distance from the slope crest (or from a point of slope change). For slope angles less than 30 deg, infiltration normal to the slope differs relatively little from infiltration from a horizontal surface. Interesting aspects of the solution include a time-dependent total horizontal flow into the slope and a time-dependent downslope total flow component that behaves as t to the 1/2 power at small t and as t at large t. Previously, hillslope flows in these directions have been discussed in terms of soil anisotropy and layering, but these flows in a homogeneous isotropic soil are simple physical consequences of capillarity and gravity. The analysis applies, with minor modification, to two simple types of hillslope anisotropy: (1) anisotropy parallel to the slope and (2) horizontal anisotropy. Type 1 yields a complicated time dependence of the horizontal flow and type 2 affects downslope flow similarly. These flow directions commonly will reverse during the course of the infiltration process. (Author's abstract)
W91-05841

USING MORPHOMETRIC EXPRESSIONS FOR MACROPORES TO IMPROVE SOIL PHYSICAL ANALYSES OF FIELD SOILS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
J. Bouma.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 3-11, March 1990. 4 fig, 32 ref.

Descriptors: *Hydrologic budget, *Macropores, *Simulation analysis, *Soil physics, *Soil properties, *Soil water, Data interpretation, Mathematical models, Model studies, Porous media, Representative elementary volume, Soil-water-plant relationships.

Soil physical measurements in field soils are essentially based on methodologies that implicitly assume that soils are isotropic and homogeneous. Use of basic physical data, thus obtained, in simulation models of the water regime may yield poor results that cannot be improved by calibration or matching procedures. For example, bypass flow along macropores has a major effect on soil water regimes and cannot be ignored. Here the use of morphological measurements of macropores is discussed and illustrated for two purposes: (1) improvement of measurement procedures for basic transport parameters in different soil structures; and (2) definition of boundary conditions for the flow system based on the occurrence and continuity of macropores. Patterns of water extraction by roots need particular attention, requiring quantification of 'accessible' water in addition to the well-established 'available' water. Use of relatively simple macro-morphological methods should be encouraged to allow widespread morphological measurements under field conditions. Future soil morphological studies in soils with macropores can contribute toward obtaining realistic base data and boundary conditions for simulation models of the soil water regime and plant growth. This can be done in several ways: (1) representative elementary volume (REV) of samples for soil physical measurements in different undisturbed soil materials may be determined by interpreting morphological soil descriptions; (2) separate measurements could be applied to subsamples of soil horizons when REVs become unrealistically large; (3) vertical continuities of macropores in the field could be measured using staining techniques; and (4) water extraction patterns by roots inside the soil matrix and along macropores may be measured using small tensiometers, TDR-equipment, or selective gravimetric sampling for water content and rooting patterns could studied in the field simultaneously. (Rochester-PTT)
W91-05873

DIRECTIONAL SATURATED HYDRAULIC CONDUCTIVITY AND MACROPORE MORPHOLOGY OF A SOIL-SAPROLITE SEQUENCE.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 2F.
W91-05875

PREFERENTIAL FLOW IN A SANDY VADOSE ZONE: 1. FIELD OBSERVATION.
Wisconsin Univ.-Madison. Dept. of Soil Science.
K. J. S. Kung.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 51-58, March 1990. 4 fig, 17 ref.

Descriptors: *Flow profiles, *Preferential flow, *Sand, *Soil water, *Vadose zone, *Wisconsin, Dye releases, Field tests, Geohydrology, Groundwater movement, Hydraulic conductivity, Root zone, Soil profiles, Soil structure, Solute transport, Tracers, Vadose water.

Field experiments of water movement in the lower portion of the unsaturated zone (i.e., vadose zone) are far more difficult to conduct than those in the root zone. Consequently, the understanding of the transport mechanism in the vadose zone is still primitive and mainly an extrapolation of the understanding of transport in the root zone. Recent results from field experiments conducted at the Hancock Agricultural Research Station indicated that water and solute applied uniformly to soil surfaces did not flow through the entire vadose zone. By using dye tracing and profile excavation, field experiments were conducted during the 1987 growing season to examine water flow patterns in the unsaturated zone of the Central Sand Area of Wisconsin. The results confirmed that preferential flow paths constitute the dominant flow path at this location. Water flowing through the root zone was funneled into concentrated flow paths that occupied only a small portion of the soil matrix in the vadose zone yet accounted from most of the transport. Water flowed through less than 50% of the whole soil matrix from 1.5-2.0 m, less than 10% from 3.0-3.5 m, and $<1\%$ from 5.6-6.6 m. These flow patterns were triggered primarily by an interbedded soil structure with textural discontinuities and inclined bedding planes. Because field experiments in the vadose zone are rare compared to those in the root zone, this concept of flow is usually assumed to be a reasonable representation of the transport mechanism in the lower portion of the unsaturated zone. The results demonstrated that this extrapolation could be very misleading because the impact of genetic interbedding structures on the lateral water movement near the soil surface had been smeared by external homogenizing forces (rooting, microbial and earthworm activities, freezing and thawing, etc.) (See also W91-05877) (Rochester-PTT)
W91-05876

PREFERENTIAL FLOW IN A SANDY VADOSE ZONE: 2. MECHANISM AND IMPLICATIONS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
K. J. S. Kung.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 59-71, March 1990. 6 fig, 1 tab, 34 ref.

Descriptors: *Flow profiles, *Path of pollutants, *Preferential flow, *Sand, *Soil water, *Vadose zone, *Wisconsin, Dye releases, Field tests, Funneled flow, Geohydrology, Groundwater movement, Hydraulic conductivity, Slopes, Soil mois-

ture retention, Soil profiles, Soil structure, Soil texture, Solute transport, Tracers.

Field experiments conducted at the Hancock Agricultural Research Station during the 1987 growing season showed that preferential flow paths were the dominant flow pattern in the Central Sand Area of Wisconsin. In a soil profile with interbedded structure, abrupt textural discontinuity and inclined bedding planes, a 'funnel' mechanism can trigger preferential flow paths. The observed preferential flow pattern differed from other preferential flow patterns mentioned in the literature (e.g., 'short circuiting' flow and 'fingering' flow). Four factors that will determine the occurrence of funneled flow are: (1) the conductivity of the upper finer layer; (2) the slope of the inclined layer; (3) the retention potential of the upper finer layer; and (4) the ponding potential. The conductivity and retention potential are determined by the soil texture, whereas the slope and ponding potential are determined by the structure of the soil profile. Soil profiles generally have some interbedded structure and textural discontinuity. Therefore, the funnel phenomenon may occur widely in the vadose zone under certain conditions. Because preferential paths are determined not only by the soil properties but by the flow itself, the use of dye for tracing water flow pattern in field experiments is an art rather than a rigorous science. A better tracing method needs to be developed. The 'funnel' phenomenon coupled with 'column' flow will have a significant impact on groundwater contamination, solute sampling technique, and transport modeling. The downward movement of a contaminant can be enhanced greatly by funneled preferential flow paths. Current solute sampling protocols in the unsaturated and saturated zones need to be redesigned in soil with preferential paths. It may be beneficial to adopt the concept of 'Stratosol' (i.e., a soil made of strata) in developing the next generation of vadose zone solute transport models generic to field conditions. (See also W91-05876) (Rochester-PTT)
W91-05877

EFFECT OF LUMBRICUS TERRESTRIS L. BURROWS ON HYDROLOGY OF CONTINUOUS NO-TILL CORN FIELDS.
Agricultural Research Service, Coshocton, OH.
W. M. Edwards, M. J. Shipitalo, L. B. Owens, and L. D. Norton.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 73-84, March 1990. 6 fig, 3 tab, 20 ref.

Descriptors: *Earthworms, *Infiltration, *Ohio, *Soil physical properties, *Soil water, *Surface-groundwater relations, *Tillage, Agriculture, Flow profiles, Maize, Prediction, Runoff, Soil porosity, Soil structure.

Research has been performed at the U.S. Department of Agricultural Agricultural Research Service North Appalachian Experimental Watershed, Coshocton, Ohio, into the importance of earthworm burrows, primarily those made by Lumbricus terrestris L., on the hydrology of no-till corn fields. Long-term runoff records showed that infiltration and, therefore, potential groundwater recharge could increase by more than 100 mm/yr in watersheds farmed with no-till practices compared to similar fields that were conventionally tilled. The difference in hydrologic response appeared to be due to differences in soil physical properties, possibly those attributable to earthworm activity. When crop residues were left on the surface under continuous no-till corn management, earthworms thrived and their large, nearly vertical burrows persisted. Field studies showed that dye and chemical tracers applied in simulated rainfall moved in the earthworm burrows. The number and sizes of burrows and other macropores were determined and water and nitrate movement in the >5 mm diameter burrows were measured. Flow in these earthworm burrows during 12 growing season storms accounted for an average 49% of rainfall (range: 1-10%) or 13 times more than would be predicted based solely on their cross-sectional area. Total movement of nitrate in the burrows during these 12 storms was estimated to be <1 kg/ha. (Author's abstract)
W91-05878

PREFERENTIAL PATHS OF FLOW UNDER CONVENTIONAL AND CONSERVATION TILLAGE.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
M. S. Andreini, and T. S. Steenhuis.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 85-102, March 1990. 10 fig, 4 tab, 24 ref.

Descriptors: *Flow pattern, *Infiltration, *Preferential flow, *Soil water, *Tillage, Agriculture, Bromides, Dye releases, Flow velocity, Soil porosity, Soil structure, Solute transport, Tracers.

Preferential solute movement through conservation and conventional tillage soil profiles was investigated by applying bromide and dye tracers to undisturbed soil columns at an application rate that did not create ponding or runoff. In both tilled and untilled soils, preferential flows were established with much of the soil well below saturation. Spatial variations in the solute flows were observed by monitoring the column effluent flowing from a grid lysimeter. Dye in effluent flowing at lower water velocity was more retarded than dye traveling in higher velocity effluent. Using grid lysimeters, interesting observations are possible that cannot be made if the column effluent is collected as a single sample per time period. Although there is an increasing awareness of the importance of preferential flows, spatial variations such as those recorded here had not been observed previously in this fashion. While some of the salient features of preferential flows seen in this experiment have been surmised by acute observers, it is evident that the complexity of solute movement in heterogeneous structured soils makes it very difficult to quantify the effects of the various factors involved. An association between higher water velocities and lower levels of retardation was demonstrated. It was observed that the dyed flow paths led to the areas where water and solute exited the column. In the no-till column, nearly the entire depth of the profile was short-circuited by preferential flow, but in the tilled column the solute passed through the mixed, unstructured plow layer before the profile below the plow pan was short-circuited. (Rochester-PTT)
W91-05879

UNSATURATED SOLUTE TRANSPORT THROUGH A FOREST SOIL DURING RAIN STORM EVENTS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
P. M. Jardine, G. V. Wilson, and R. J. Luxmoore.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 103-118, March 1990. 8 fig, 1 tab, 33 ref. USDOE Contract DE-AC95-84OR21400.

Descriptors: *Forest soils, *Soil porosity, *Soil water, *Solute transport, *Surface-groundwater relations, Bromides, Flow pattern, Flow velocity, Neutron probes, Porosity, Storms, Tensiometers.

The unsaturated transport of bromide through two distinct pore classes of an undisturbed pedon was investigated as a function of time and profile depth for a series of intermittent rain events. Water movement was monitored with tensiometers and a neutron probe and solute was collected in coarse and fine fritted glass solution samplers maintained at 2 and 10 kPa suction, respectively. The coarse samplers collected soil solution held at tensions of 0 to 2 kPa and are believed to have monitored predominantly macropore and mesopore channels (large pores). The fine samplers are thought to have collected soil solution from predominantly matrix mesopores (small pores), which are assumed to be approximately the lower pore size limit for gravitationally mobile water in this soil. The rate of tracer movement through large and small pores depended on the intensity and duration of a particular rain event as well as on the antecedent soil water content. Small pores retained water and solutes longer and had a greater operational storage for ions than large pores. The data suggested that during the vertical flux of water through the soil profile, solutes were transported by convection and diffusion from small-pore regions to large-pore regions via hydraulic and concentration gradients, respectively, with small pores being a major source for solute transport in large pores. Because of physical and chemical nonequilibrium during rain events, solutes diffused from micropores (believed to have matric potentials > 10 kPa) into large and small pores. Solutes that were transported rapidly to greater depths through large pores increased the solute reserves in adjacent small pores at the same depths through a reversal of the mechanism described above. Solute reserves in small pores also were fed by significant vertical transport processes through this pore class. (See also W91-05881) (Author's abstract)
W91-05880

HYDROLOGY OF A FORESTED HILLSLOPE DURING STORM EVENTS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. V. Wilson, P. M. Jardine, R. J. Luxmoore, and J. R. Jones.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 119-138, March 1990. 8 fig, 3 tab, 39 ref. USDOE Contract DE-AC05-84OR21400.

Descriptors: *Forest soils, *Forest watersheds, *Rainfall-runoff relationships, *Soil water, *Storm water, *Subsurface flow, Flood hydrographs, Flood peak, Flow profiles, Infiltration, Slopes, Storms, Tennessee, Walker Branch Watershed.

Subsurface flow from a 0.47-ha hillslope catchment at the uppermost reach of the West Fork (38 ha) of Walker Branch Watershed (Tennessee) was monitored throughout 1988. Stormflow in the first-order stream draining the West Fork responded simultaneously with the initiation of subsurface flow through 0 to 2.5 m depth from the hillslope. Subsurface flow from the upper hillslope was only 1.3% of total precipitation for 1988, but individual storms yielded as much as 12.5% of precipitation as subsurface flow. The West Fork had 10.4% of precipitation observed as storm flow with an additional 29% as baseflow. Individual storms exhibited up to 71% of precipitation as storm flow in the West Fork, illustrating the significant increase in percent rain converted to subsurface flow lower landscape positions compared to upper hillslopes. Peak subsurface flow preceded peak streamflow and occurred primarily through the 1.0-2.5 m depth (Bt2 horizons) due to perched water tables. Preferential flow from hillslopes through macro-, and mesopores was concluded to be the predominant stormflow mechanism. The contributions of the pores of various sizes were reasoned to depend on the position the within the soil profile and the stage of the hydrograph. Preferential flow occurred at extreme soil water conditions with the response due to perched water tables under wet conditions and believed to be due to hydrophobic conditions under extremely dry conditions. Intermediate soil water conditions resulted in infiltration into soil matrix pores precluding subsurface stormflow. (See also W91-05880) (Author's abstract)
W91-05881

PHYSICAL AND CHEMICAL CONTROLS OF PREFERRED PATH FLOW THROUGH A FORESTED HILLSLOPE.
Oak Ridge National Lab., TN.
R. J. Luxmoore, P. M. Jardine, G. V. Wilson, J. R. Jones, and L. W. Zelazny.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 139-154, March 1990. 8 fig, 1 tab, 29 ref. USDOE Contract DE-AC05-84OR21400.

Descriptors: *Adsorption, *Forest soils, *Infiltration, *Preferential flow, *Soil porosity, *Soil water, *Solute transport, Aluminum, Calcium, Cations, Flood peak, Forest watersheds, Hydrographs, Iron, Macropores, Magnesium, Manganese, Mesopores, Potassium, Sodium, Soil structure, Sulfur.

Investigations were conducted of the physical and chemical characteristics of macropores and mesopores at two forested sites established for subsurface transport research. The hydrologically active macroporosity (pores > 1 mm diameter) is a very

small fraction of the total soil porosity, but is sufficient to conduct a large proportion of ponded infiltration. Mesopores (pores < 1 mm diameter that are generally drained at field capacity) are sufficient to conduct total infiltration during the majority of rain events and have a much higher surface area than total infiltration during the majority of rain events and have a much higher surface area than macropores. The cation adsorption coefficient of macropore walls was similar to bulk soil for mineral coatings, but was higher for organic linings derived from roots. The subsurface outflow from a 0.46-ha subwatershed generated by two precipitation events displayed two contrasting patterns of chemical concentration. At the time of peak discharge, the concentration of Na, K, Mg, Ca, and S was close to maximum (high supply); and for Al, Fe, and Mn, chemical concentration was highest prior to peak discharge (low supply). A pathlength-supply hypothesis is proposed based on: (1) the changing proportions of mesopore flow path lengths with stage of the subsurface hydrograph; and (2) the ability of mesopore surfaces and adjacent micropores to continue supplying chemicals to percolating soil water. Macropores are viewed as being important physical conduits in convergent flow zones of watersheds but as having little influence on water quality. (Author's abstract)
W91-05882

FLUID FLOW IN PARTIALLY SATURATED, WELDED-NONWELDED TUFF UNITS.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W91-05883

MODELING SOLUTE TRANSPORT IN STRUCTURED SOILS: A REVIEW.
Florida Univ., Gainesville. Dept. of Soil Science.
M. L. Brusseau, and P. S. C. Rao.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 169-192, March 1990. 2 fig, 117 ref. Florida Dept. Env. Reg. Contract WM-254.

Descriptors: *Hydrologic models, *Literature review, *Soil water, *Solute transport, Mathematical equations, Mathematical models, Performance evaluation, Porous media, Simulation analysis, Soil porosity, Soil structure, Sorption.

Solute transport in structured soils is and has been the focus of a significant research effort. Transport in such systems often is characterized by nonideal phenomena. These phenomena have usually been ascribed to the presence of immobile domains within the porous medium, which results in physical nonequilibrium. The phenomena can also, in some cases, be attributed to rate-limited sorption (i.e., sorption nonequilibrium). These processes often are modeled using a bicontinuum approach. It might be expected, for field-scale problems, that nonequilibrium may be the result of more than one contributing process. A model that explicitly accounts for multiple sources of nonequilibrium would be preferable for such cases. The models employing the diffusion equation are intellectually pleasing because they employ a truly mechanistic approach. These models have been successfully used for simplified systems. However, once 'real' soil is considered, with all of its complexity, the usefulness of these models becomes questionable. For example, to apply these models both the size and shape distributions of the structures (e.g., the aggregates) are required. Application of these models to systems influenced by processes other than transport nonequilibrium can yield erroneous results. The physical mass-transfer (two-region) and the two-site sorption models are mathematically equivalent for the linear isotherm case when written in dimensionless form. A major advantage of the mass-transfer models over the diffusion-based models is that a description of the structure of the porous medium is not required. The choice among the available mathematical models for simulating solute transport under nonequilibrium conditions is constrained by available data and the purpose of the modeling effort. It is essential to distinguish between mathematical models and the conceptual models they represent. The use of any mathematical model should be based on a sound understanding of the processes being modeled. The various models developed for simulating solute transport under nonequilibrium conditions are reviewed. (Rochester-PTT)
W91-05884

NUMERICAL MODEL FOR PREFERENTIAL SOLUTE MOVEMENT IN STRUCTURED SOILS.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
T. S. Steenhuis, J. Y. Parlange, and M. S. Andreini.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 193-208, March 1990. 6 fig, 38 ref, append.

Descriptors: *Hydrologic models, *Mathematical models, *Preferential flow, *Soil water, *Solute transport, *Vadose zone, Flow profiles, Flow velocity, Hydraulic conductivity, Mathematical studies, Model studies, Numerical analysis, Performance evaluation, Porous media, Soil porosity, Soil structure.

A model was developed for preferential in the vadose zone. In the model a piecewise linear approximation of the hydraulic conductivity as a function of water content is used to identify the flow paths (or pore groups) in which water moves at distinct velocities. By choosing the linear approximations in such a way that the velocity in a pore group is an integer multiple of the velocity and the adjoining pore group, a simple numerical procedure can be formulated for simulating solute movement. The character of the solute exchange among the pore groups may be altered as demanded by the nature of the system being modeled. If complete mixing among the pore groups is specified, the model is reduced to the convective-dispersive equation. If no mixing is specified, it behaves as a pore bundle model. (Author's abstract)
W91-05885

LAPLACE TRANSFORM GALERKIN TECHNIQUE FOR EFFICIENT TIME-CONTINUOUS SOLUTION OF SOLUTE TRANSPORT IN DOUBLE-POROSITY MEDIA.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
E. A. Sudicky.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 209-232, March 1990. 6 fig, 3 tab, 33 ref. University Research Fellowship Grant No. U0508.

Descriptors: *Data interpretation, *Laplace transform Galerkin technique, *Mathematical studies, *Porous media, *Soil water, *Solute transport, Aquifers, Finite element method, Galerkin method, Hydraulic conductivity, Laplace equation, Mathematical equations, Porosity, Sand aquifers.

A new and efficient technique has been devised for the numerical solution of solute transport problems in multi-dimensional double-porosity media. The method is based on the Laplace Transform Galerkin (LTG) technique and employs a convolution integral in the governing advection-dispersion equation to express the diffusive exchange of solute between the mobile and immobile regions. Because the Laplace transformation is applied to the advection-dispersion equation describing transport in the mobile region, the convolution integral, in addition to the temporal derivative, is effectively removed. After the transformed equation is solved using the Galerkin finite element method, nodal concentrations in the time-domain are obtained using a robust and efficient algorithm for inversion of the Laplace-domain nodal concentrations. The method permits the solution to be evaluated at any future point in time without any need for time steps, and permits the use of grids having a relatively coarse spatial discretization while avoiding significant numerical dispersion. Further computational efficiency is achieved for large-grid problems by employing an ORTHOMIN-accelerated iterative solver to solve the system of Laplace-domain finite element equations. Influence functions describing the mobile-immobile region solute transfer are presented here for the case of slab and sphere geometries, for the mobile-immobile zone, and for the case of first-order exchange theory, along with expressions that unify the three approaches. The utility of the model is demonstrated by applying it to the problem of solute transport in a sandy-type aquifer having a random, spatially-correlated hydraulic conductivity field and comprised of slightly porous grains that admit intragranular diffusions but do not conduct fluid. (Author's abstract)
W91-05886

USE OF TEMPORAL MOMENT ANALYSIS TO STUDY REACTIVE SOLUTE TRANSPORT IN AGGREGATED POROUS MEDIA.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
A. J. Valocchi.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 233-247, March 1990. 2 fig, 29 ref. NSF Grant CEE-8204434.

Descriptors: *Data interpretation, *Groundwater movement, *Mathematical studies, *Numerical analysis, *Porous media, *Soil water, *Solute transport, Adsorption, Hydrologic models, Method of moments, Performance evaluation, Temporal moment analysis.

When both adsorption reactions and heterogeneous structure are taken into account, the resulting mathematical transport models are extremely complex, often requiring numerical solution techniques. However, in certain cases it is possible to use the so-called 'method of moments' to derive analytical results for integrated features of the solution of complex transport models. Temporal moments are useful in one-dimensional systems, such as laboratory-scale soil columns. An overview is presented here of the use of temporal moment analysis as a useful alternative to more complete analytical and numerical solutions of mathematical models describing adsorbing solute transport in aggregated, saturated porous media. The goal of temporal moment analysis is to derive analytical formulas for the lower-order time moments of the solute breakthrough curve, thereby yielding significant physical insight into the behavior of solute transport models. Basic results show that the time moments are completely determined by a mobile-immobile zone transfer function. This transfer function can be calculated easily as long as all mathematical relationships are linear. Hence, one of the most significant limitations of temporal moment analysis is its restriction to linear solute transport models. (Rochester-PTT)
W91-05887

INFERENCES ABOUT SOLUTE TRANSPORT IN MACROPOROUS FOREST SOILS FROM TIME SERIES MODELS.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
G. M. Hornberger, K. J. Beven, and P. F. Germann.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 249-262, March 1990. 4 fig, 2 tab, 30 ref. EPA Agreement CR813575-01-02.

Descriptors: *Forest soils, *Macropores, *Preferential flow, *Soil porosity, *Soil water, *Solute transport, *Time series analysis, Flow velocity, Maine, Mathematical models, Performance evaluation, Potassium bromide, Tracers, Transfer functions.

Solutes can move along macropores and other preferred flow channels in forest soils when input rates at the surface are high enough. In natural systems, the actual flow paths are, to all intents and purposes, indeterminate. The use of transfer function models to represent solute transport has been proposed under these circumstances. Parameters were estimated in a discrete-time version of a transfer function model for a sequence of experiments performed by sprinkling an isolated soil block in a forested catchment near Orono, Maine. All experiments were performed at steady flow by adding a quantity of water labeled with potassium bromide. The travel time of solute in the soil block was computed for each of three application rates and the effective mixing volume of the solute

within the block was inferred from the time series parameters. Results show that significant macropore flow occurs in the soil block. Despite the importance of macropore flow, the fractional volume of the total pore water that participates in solute transport decreases only slightly with increasing flow rate. (Author's abstract)
W91-05888

WATER MOVEMENT THROUGH AN AGGREGATED, GRAVELLY OXISOL FROM CAMEROON.
Florida Univ., Gainesville. Dept. of Soil Science.
P. R. Anamosa, P. Nkedi-Kizza, W. G. Blue, and J. R. Sartain.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 263-281, March 1990. 10 fig, 5 tab, 37 ref.

Descriptors: *Cameroon, *Flow profiles, *Hydrologic models, *Oxisols, *Soil water, Adsorption, Breakthrough curves, Dispersivity, Macropores, Mathematical models, Model studies, Simulation analysis, Soil columns, Soil properties, Solute transport, Tritium.

Increasing population pressures have caused increased utilization of the gravelly (stone line) soils common to the hilly landscapes of equatorial Africa. A study was conducted to determine if macropore water flow and immobile-water regions should be considered in describing solute movement while developing nutrient-management strategies. Breakthrough curves (BTCs) from miscible displacement experiments with tritiated water were measured from 70-cm long by 9.6 cm internal diameter, water-saturated, undisturbed soil columns. Simulations produced by theoretical transport models were fitted to the BTCs to determine the magnitude of dispersivity and immobile-water regions. Gravel separates composed of kaolinite, gibbsite, goethite, and manganese oxides had porosities ranging from 0.13 to 0.32 cu m/cu m, with a composite sample porosity of 0.20 cu m/cu m. Adsorption coefficients of tritium ranged from 0.031 to 0.052 ml/g for the three horizons in the soil columns. Columns containing gravel (30% by volume and 62% by weight) gave asymmetrical BTCs. A convective-dispersive transport model failed to simulate observed BTCs accurately. The mobile/immobile (MIM) water model provided close agreement to BTCs obtained at flow rates ranging from 2.71 to 111 cm/d. The water-saturated soil columns had about 50% of all water in immobile regions. Soil water dispersivity was 3.3 cm to the 2-n power times d to the n-1 power (with empirical constant n = 1.3) from a curvilinear plot of the dispersion coefficient and the mobile porewater velocity. Parameters estimated from one column were applied to the BTCs of a similar soil column. The MIM model showed close agreement between the measured and the independently estimated BTCs. These soil characteristics can contribute to the rapid deep transport of a limited quantity of solute and to the storage and/or slow diffusive mass transport of the remaining solute from within immobile regions. (Author's abstract)
W91-05889

EFFECT OF SOLUTE APPLICATION METHOD ON PREFERENTIAL TRANSPORT OF SOLUTES IN SOIL.
Iowa State Univ., Ames. Dept. of Agronomy.
G. J. Kluitenberg, and R. Horton.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 283-297, March 1990. 3 fig, 3 tab, 23 ref. Iow Agriculture and Home Economics Experimental Station Project Nos. 2556 and 2715.

Descriptors: *Preferential flow, *Soil chemistry, *Soil porosity, *Soil water, *Solute transport, Absorption, Calcium chloride, Calcium sulfate, Diffusion, Geochemistry, Hydraulic conductivity, Infiltration, Macropores.

In soils containing macropores, both water and solutes can move preferentially, bypassing much of the soil matrix. The present study sought to examine the effect of a solute application method on preferential solute transport in soil materials containing differing amounts of macroporosity. Transport experiments were conducted with three undisturbed soil columns (18 cm diameter, 33-35 cm long) that contained extensive networks of macropores. The macroporosity of the soil columns first was characterized by measuring the saturated hydraulic conductivity and drained porosity, and by conducting saturated, steady-fluid-flow miscible displacement experiments in which a 0.05 N CaCl2 solution displaced a 0.01 N CaSO4 solution. These measurements indicated extensive macroporosity and a range in macroporosity among the three columns. Two transport experiments then were conducted with each of the three columns. The initial moisture condition of the soil in both experiments was a gravity-drained profile. In the first transport experiment, a 200-ml pulse of 0.05 N CaCl2 solution was ponded on the surface of each of the three columns and allowed to infiltrate. A solution of 0.01 N CaSO4 then was ponded immediately on the soil surface. In the second set of transport experiments, after leaching the excess chloride remaining in the columns from the first experiment, 40 ml of 5-fold more concentrated CaCl2 solution (0.25 N CaCl2) was dripped uniformly on the soil surface of the same three columns (no ponding), allowed to redistribute for 15 min, and then leached with a steady flow of 0.01 N CaSO4 solution. The resulting breakthrough curves for the two solute application methods were distinctly different, indicating a sensitivity of the transport process to solute application method, or solute-boundary condition. In addition, the curves showed that the sensitivity to application method decreased with decreasing soil macroporosity. The initial water status of the soil macropores, saturated or drained, is important in determining the degree of dispersion that takes place in individual macropores and thus in the soil as a whole. (Author's abstract)
W91-05890

VARIABILITY OF SOIL WATER TENSION AND SOIL WATER CONTENT.
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
J. M. Hendrickx, P. J. Wierenga, and M. S. Nash.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 135-148, July 1990. 3 fig, 4 tab, 33 ref.

Descriptors: *Moisture, *Soil properties, *Soil water, Field tests, Hydraulic conductivity, Soil moisture retention, Soil physics, Tension.

Variability in soil water tension and in soil water content in a field soil was assessed in order to explain the contradictory data concerning the soil water content of drying soil. A transect was established with 91 positions 1 meter apart. Soil water content was measured 16 times at 0.3 meter depth before and after flooding of the transect. Soil water content was measured 13 times after flooding. Applications of the split moving-window technique resulted in the detection of three boundaries partitioning the transect in four homogeneous segments. For each of these segments, the variability of soil water tension and water content significantly increased when the soil dried out. This experimental result confirmed the theoretical result obtained by previous investigators who used a stochastic model to predict the standard deviation in tension for moist soils, assuming unsaturated hydraulic conductivity is an exponential function of soil water tension. When the water content goes to zero in very dry soils, the variability in soil water content should decrease. However, data from this study and from the literature suggest that the variability in soil water tension in dry soil remains more or less constant at a high level. The relationship between soil water content and tension was found to be linear for the investigated soil. Therefore, the variability of soil water tension and soil water content are quantitatively related by the slope of the soil water retention curve. (Author's abstract)
W91-05925

2H. Lakes

AIRBORNE MERCURY DEPOSITION AND WATERSHED CHARACTERISTICS IN RELATION TO MERCURY CONCENTRATIONS IN WATER, SEDIMENTS, PLANKTON AND FISH OF EIGHTY NORTHERN MINNESOTA LAKES.
Minnesota Univ., Duluth. Coll. of Science and Engineering.
For primary bibliographic entry see Field 5B.
W91-04951

PHASES IN THE DEVELOPMENT OF RIVERINE PLANKTON: EXAMPLES FROM THE RIVERS RHINE AND MEUSE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04961

REEUWIJK LAKES: A FIVE YEARS WATER QUALITY STUDY IN AN EUTROPHIC ECOSYSTEM.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04962

MODELLING PHOSPHORUS FLUXES IN THE HYPERTROPHIC LOOSDRECHT LAKES.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04963

MODEL ON THE COMPETITION BETWEEN TWO MACROPHYTE SPECIES IN ACIDIFYING SHALLOW SOFT-WATER LAKES IN THE NETHERLANDS.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Ecotoxicology, Environmental Chemistry and Drinking Water.
For primary bibliographic entry see Field 5C.
W91-04964

OIL AND GAS ACTIVITY AND LOUISIANA WETLAND LOSS.
Louisiana State Univ., Baton Rouge. Dept. of Economics.
For primary bibliographic entry see Field 4C.
W91-04966

ELEMENTAL CONCENTRATIONS IN FISHES FROM THE SALTON SEA, SOUTHEASTERN CALIFORNIA.
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
For primary bibliographic entry see Field 5B.
W91-04968

ROLE OF WEATHERING AND FORESTRY IN DETERMINING THE ACIDITY OF LAKES IN SWEDEN.
Lund Inst. of Tech. (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W91-04970

EFFECTS OF LIMING ON NUTRIENT LIMITATION OF EPILITHIC ALGAE IN AN ACID LAKE.
West Chester Univ. of Pennsylvania. Dept. of Biology.
For primary bibliographic entry see Field 5G.
W91-04974

EFFECTS OF INCREASING ACIDITY ON AQUATIC PROTOZOAN COMMUNITIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W91-04976

INFLUENCE OF LABELLED FOOD TYPE ON THE ACCUMULATION AND RETENTION OF

60-CO BY A FRESHWATER FISH, CYPRINUS CARPIO L.
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Inst. de Protection et de Surete Nucleaire.
For primary bibliographic entry see Field 5B.
W91-04979

CHLORIDE IN THE PORE WATER AND WATER COLUMN OF ONONDAGA LAKE, N.Y., U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
For primary bibliographic entry see Field 5B.
W91-04983

SEDIMENT SEEDBANKS IN GRASSLANDS ON THE MAGELA CREEK FLOODPLAIN, NORTHERN AUSTRALIA.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
C. M. Finlayson, I. D. Crowie, and B. J. Bailey.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 163-176, November 1990. 1 fig, 1 tab, 19 ref.

Descriptors: *Grasslands, *Magela Creek, *Riparian vegetation, *River sediments, *Stream banks, Australia, Flood plains, Seedlings, Species composition, Species diversity.

The size and species composition of plant populations arising from sediment seedbanks of three communities (Pseudoraphis, Hymenachne, and Oryza grasslands) on the Magela Creek floodplain were compared under experimental (moist and flooded) conditions. The mean number of seedlings produced in the moist treatment ranged from 8,000 to 15,400/sq m, and in the flooded treatment ranged from 3,800 to 7,100/sq m. Seeds from 33 taxa germinated: 22 from Oryza; 13 from Pseudoraphis; and 18 from Hymenachne-site samples. In terms of the species present the Pseudoraphis-site seedbank closely reflected that of its community on the floodplain, whereas the Hymenachne-site and the Oryza-site seed banks were not closely related to the composition of their respective flood plain communities. Indicies of diversities and evenness point to the relative homogeneity of species seedbank production in the moist treatment of Pseudoraphis-site and Hymanachne-site samples, compared with that in both treatments of the Oryza-site samples and the floodplain treatment of pseudoraphis-site and Hymanachne-site samples. Pseudoraphis spinescens Vick, with a relatively small but persistent seed, dominated the seedling composition of the Pseudoraphis-site and Hymanachne-site samples. (Author's abstract)
W91-04985

COMPETITION FOR SPACE BETWEEN EICHHORNIA CRASSIPES (MART.) SOLMS AND PISTIA STRATIOTES L. CULTURED IN NUTRIENT ENRICHED WATER.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
M. Agami, and K. R. Reddy.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 195-208, November 1990. 4 fig, 3 tab, 39 ref.

Descriptors: *Aquatic plants, *Competition, *Limnology, *Plant growth, *Water hyacinth, *Water lettuce, Aquatic weeds, Macrophytes, Nitrogen, Nutrients, Phosphorus, Plant populations.

The interrelationship between two free-floating aquatic macrophytes, Eichhornia crassipes (Mart.) Solms and Pista stratiotes L, were investigated using a reciprocal replacement series for the intermixed combinations. The carrying capacity of each species was investigated in monoculture. The plants were cultured in outdoor tanks in Gainesville, Florida, where nutrient enriched water was replenished at weekly intervals. E. crassipes showed dominance over P. stratiotes when the species were grown together. Interaction between the two species for growth space became apparent within the first month of the experimental period. The luxuriant growth and high plasticity of E. crassipes plants enabled them to grow above the P. stratiotes plants, thus shading and stressing them. Higher concentrations of nitrogen (by about two fold) were accumulated in the shoots of E. crassipes than in its roots, whereas N accumulation in the roots and shoots of P. stratiotes was similar. The N content of E. crassipes shoots increased throughout the experimental period, about six fold, while the N content of the roots increased two fold. Phosphorus accumulation was equally distributed between the roots and shoots of both species. (Author's abstract)
W91-04986

EFFECTS OF NITRATE, AMMONIUM AND SALINITY ON GROWTH OF THE MANGROVE BRUGUIERA GYMNORRHIZA (L.) LAM.
Durban-Westville Univ. (South Africa). Dept. of Botany.
G. Naidoo.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 209-219, November 1990. 4 fig, 1 tab, 30 ref.

Descriptors: *Ammonium, *Aquatic plants, *Mangrove swamps, *Nitrates, *Plant growth, *Salinity, *Wetlands, Biomass, Nitrogen.

Experiments were conducted over 8 months via two solution culture studies on the effects of nitrate, ammonium and salinity on the growth of Bruguiera gymnorrhiza. In the first, at 100 mol/cu m NaCl, dry matter accumulation increased with an increase in added nitrogen from 0 to 10 mg/L NO3-N and from 0 to 15 mg/L NH4-N. Thus, this species assimilates both forms of inorganic N. Further increases in added N to 20 mg/L decreased biomass, even though tissue N concentration increased. Trends in total leaf area, area per leaf, and specific leaf area paralleled those for dry biomass. In the second experiment, at 20 mg/L NH4-N, the accumulation of dry matter and photosynthetic leaf area were maximal at 50 mol/cu m NaCl and declined at higher salinities up to 250 mol/cu m. The data suggested that growth enhancement in response to added N occurs at low salinities. Higher salinities tend to reduce biomass, even at high levels of added N. There were significant effects of N source and concentration, as well as salinity, on N content, biomass accumulation and photosynthetic leaf area. (Author's abstract)
W91-04987

GAS EXCHANGE AND CARBON FIXATION PROPERTIES OF THE MAT-FORMING CYANOPHYTE LYNGBYA BIRGEI G. M. SMITH.
Florida Univ., Gainesville. Dept. of Botany.
S. Beer, W. Spencer, G. Holbrook, and G. Bowes.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 221-230, November 1990. 5 tab, 35 ref. Florida Department of Natural Resources Contract N0. C3635, and USDA Grants 86-CRCR-1-2109 and 88-37130.

Descriptors: *Algae, *Aquatic weeds, *Bacterial growth, *Carbon cycle, *Cyanophyta, *Limnology, Bacteria, Biomass, Carbon dioxide, Photosynthesis.

The macroscopic cyanophyte Lyngbya birgei G. S. Smith showed low, O2-insensitive rates of CO2 release into CO2-free media, as well as low CO2 compensation points and O2 insensitive photosynthetic rates. These gas exchange rates indicate that this organism can suppress photorespiration. The ability to optimize photosynthetic rates is based on HCO3(-) use as well as limited C4-like metabolism. Both systems could elevate CO2 levels and thereby reduce the oxygenase activity of ribulose-1,5-bisphosphate carboxylase/oxygenase. It was further found that while the low photorespiration state did not change in Lyngbya grown at various inorganic carbon levels, the enzymatic potential for C4 metabolism varied with external HCO3(-) levels. It is suggested that Lyngbya has adapted its photosynthetic systems to be efficient so as to ensure optimal production in a variety of inorganic carbon and O2 environments, and that this ability is of competitive advantage under conditions where it becomes an aquatic weed. (Author's abstract)
W91-04988

EFFECT OF CANOPY FORMATION BY FLOATING AND SUBMERGENT AQUATIC MACROPHYTES ON THE WATER QUALITY OF TWO SHALLOW PACIFIC NORTHWEST LAKES.
Washington Cooperative Fishery Research Unit, Seattle.
J. D. Frodge, G. L. Thomas, and G. B. Pauley.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 231-248, November 1990. 9 fig, 2 tab, 24 ref.

Descriptors: *Aquatic plants, *Dissolved oxygen, *Limnology, *Macrophytes, *Plant growth, *Water quality, Aquatic weeds, Bull Lake, Hydrogen ion concentration, Keevies Lake, Submerged aquatic plants, Washington.

Dense mats of aquatic macrophytes partitioned the littoral zone of two shallow lakes in Washington State into differing habitats of varying water quality. Horizontal distribution of dissolved oxygen (DO) and pH in the lakes was associated with the patchy distribution of aquatic macrophytes in the lake, and the vertical distribution of DO and pH was associated with the location of the canopy in the water column. Elevated concentrations of DO and pH were observed in the canopies of submergent species, while lower DO and pH concentrations were seen in both the canopies of floating-leaved species and in the sub-canopy water of both growth forms. Open waters were mixed to a greater extent than within macrophyte beds, resulting in higher subsurface DO concentrations than beneath either submergent or floating plant canopies. Diel changes in DO and pH were associated with the growth form of the macrophytes that formed the plant canopy. In Keevies Lake, in western Washington, dense canopies of overlapping floating leaves of Brasenia schreberi Gmel., reduced summer surface and sub-canopy DO to <2 mg/L without significantly changing pH. In canopies of Potamogeton natans L., which has subsurface as well as floating leaves, the surface DO concentration was higher than in adjacent open water areas; but sub-canopy DO was as low as beneath B. schreberi canopies. In Bull Lake, in Eastern Washington, surface canopies of the submergent species Ceratophyllum demersum L. and Myriophyllum exalbescens (fern.) Jeps., regularly had DO concentrations of > 30 mg/L and pH > 10. Beneath these canopies of submergent plants, DO of < 1 mg/L was common at 0.25-0.50 m, and pH was typically 1-2 units lower than at the surface. (Lantz-PTT)
W91-04989

ABSENCE OF ALLELOPATHIC EFFECTS OF CHARA ON PHYTOPLANKTON IN SITU.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
C. Forsberg, S. Kleiven, and T. Willen.
Aquatic Botany AQBODS, Vol. 38, No. 2/3, p 289-294, November 1990. 2 fig, 24 ref.

Descriptors: *Algae, *Chara, *Limnology, *Phytoplankton, Biomass, Nutrients, Phosphorus, Photosynthesis, Productivity.

Chemical compounds isolated from Chara have been shown to inhibit algal photosynthesis in laboratory experiments, supporting the concept of negative allelopathy in Chara. However, evidence for this phenomenon in situ has not been obtained. Studies of the relationships between lake phosphorus levels and phytoplankton biomass in six Chara lakes demonstrated that these lakes have a phytoplankton biomass of predictable size. This indicates that Chara does not release allelopathic compounds in situ. The reported densities of epiphytes on these plants also indicate the absence of allelopathy by Chara in situ. (Author's abstract)
W91-04990

FACTORS THAT DELAY COLONIZATION OF FRESH ALDER LEAVES BY AQUATIC HYPHOMYCETES.
Exeter Univ. (England).
F. Barlocher.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 249-255, September 1990. 1 fig, 2 tab, 20 ref.

Descriptors: *Alder trees, *Decomposition, *Detritus, *Invertebrates, *Leaves, Aquatic environment, Asellus, Biodegradation, Fungi, Gammarus.

Air-dried leaves of Alnus glutinosa lost more soluble substances during two days of leaching than fresh leaves. Homogenizing the leaves increased the yield of leachable substances. Drying had no apparent effect on leaf surface morphology as seen under the scanning electron microscope (SEM). Leachates of whole or homogenized dried leaves and of homogenized fresh leaves stimulated growth of five species of aquatic hyphomycetes at low concentrations; at higher concentrations (7.5 g/20 ml agar medium), they inhibited radical growth by between 23.3 and 38.9%. Gammarus pulex and Asellus aquaticus did not show a clear preference when given a choice between fresh and dried, or fresh and leached leaves. Both invertebrates clearly preferred stream-conditioned leaves over fresh leaves. (Author's abstract)
W91-04995

SPECTRAL DISTRIBUTION CHARACTERISTICS IN DOWNWELLING IRRADIANCE AND OPTICAL PROPERTIES WITHIN THE EUPHOTIC LAYER IN THE NORTH BASIN OF LAKE BIWA.

Kinki Univ., Higashiosaka (Japan). Dept. of Fisheries.
R. Tsuda, and M. Nakanishi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 279-292, September 1990. 8 fig, 2 tab, 27 ref.

Descriptors: *Euphotic zone, *Lake Biwa, *Limnology, *Optical properties, *Spectral analysis, Algae, Chlorophyll a, Classification, Irradiation, Japan, Physical properties, Suspended solids.

Measurements of downwelling spectral irradiance at various depths were performed during one year (May 1983-May 1984) at a fixed station in the north basin of Lake Biwa. The patterns of spectral distribution could be classified into three types, which were related to the chlorophyll-a (chl-a) concentration within the euphotic layer. The classification in each type was also examined from the spectral values of the diffuse attenuation coefficient. The depth Z(1%), the euphotic depth, is determined as a function of the average pigment content in the offshore water, and if its content increases with decreasing depth Z(1%), the optical properties within the euphotic layer are determined by the biogenous material. However, in inland and coastal waters, the depth Z(1%) is markedly reduced by suspended sediment or detrital substances. Euphotic depth varied between 9.0 and 17.6 m during the study period, which means that the concentration of suspended matter within the euphotic layer varied considerably during the year. Generally, when the chl-a amounts exceeded about 50 mg/sq m, the depth Z(1%) decreased regularly with increasing chl-a amounts. In contrast, the presence of low chl-a amounts within the euphotic layer did not follow this general rule. In the north basin of Lake Biwa, the total quantity of suspended particles in the water fluctuates complicatedly depending on both allochthonous and autochthonous materials. These fluctuations strongly influence the determination of the euphotic depth, which is caused not only by phytoplankton abundance but also by other particles. (Lantz-PTT)
W91-04996

COMPARATIVE ASSESSMENT OF LINE TRANSECT AND POINT INTERCEPT METHODS FOR STREAM PERIPHYTON.

North-Eastern Hill Univ., Shillong (India). Dept. of Botany.
J. Rout, and J. P. Gaur.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 293-298, September 1990. 2 tab, 18 ref.

Descriptors: *Data interpretation, *Mathematical studies, *Periphyton, *Sampling, *Stream biota, Algae, Bacillariophyceae, Chlorophyta, Comparison studies, Cyanophyta, Species composition.

The feasibility of using line transect and point intercept methods to obtain a representative stream sample of periphyton from two streams which drain forested catchments in India was examined. The streams had three major algal physiognomic forms (encrusting, filamentous, colonial), and total algal cover ranged from 35% to 45%. Encrusting forms were most abundant. The stream bed had 82 algal taxa belonging to Cyanophyta (8 species), Chlorophyta (12 species) and Bacillariophyta (62 species). Comparison of line transect and point intercept did not reveal any difference. Therefore, the point intercept method may be used for the sampling of stream algae if time is the major constraint. (Lantz-PTT)
W91-04997

PHYTOPLANKTON OF A WARM MONOMICTIC LAKE--LAKE VEGORITIS, GREECE.

Thessaloniki Univ., Salonika (Greece). Inst. of Botany.
M. Moustaka-Gouni, and G. Nikolaidis.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 299-313, September 1990. 5 fig, 2 tab, 27 ref. Greek Ministry of Agriculture Grant No. 8586705.

Descriptors: *Lake Vegoritis, *Limnology, *Phytoplankton, *Species composition, Algae, Biomass, Chlorophyta, Chrysophyta, Cryptophyta, Cyanophyta, Diatoms, Dinoflagellates, Eutrophic lakes, Greece, Nitrogen, Nutrients, Phosphorus, Seasonal variation.

In the warm monomictic Lake Vegoritis, which is located in a heavily industrialized area of Greece, high concentrations of inorganic nitrogen were recorded but phosphorus was still low. The monthly fluctuations of the total phytoplankton biomass presented three annual maxima, resembling that of many eutrophic lakes with high levels of summer algal biomass. A total of 74 taxa have been recorded in the phytoplankton of Lake Vegoritis. Cyanophytes, dinoflagellates and diatoms were the major constituents of the lake's phytoplankton; chlorophytes, chrysophytes and cryptophytes formed a considerable part of the total biomass while haptophytes a very small one. The highest phytoplankton biomass was recorded in August 1988, when the large-sized phytoplankter M. aeruginosa and C. hirundinella predominated. The total biomass minimum in December, when nutrients were available, may be due to low temperature, low light intensity and optically-deep mixed column. Considerable differences in the horizontal distribution of the phytoplankton in the pelagic zone of the lake occur only during thermal stratification and the average biomass of the shallower region is greater than in the deeper. During the mixing period phytoplankton is homogenously distributed in the water column, whereas during stratification the maximum biomass is recorded in the upper 10 m (epilimnion). The phytoplankton cycle in Lake Vegoritis displays many features of the periodicities observed in other temperate mesotrophic and eutrophic lakes. (Lantz-PTT)
W91-04998

OCCURRENCE AND DISTRIBUTION OF METHANE THIOL AND OTHER VOLATILE SULPHUR COMPOUNDS IN A STRATIFIED LAKE WITH ANOXIC HYPOLIMNION.

Institut Fresenius Chemische und Biologische Laboratorien G.m.b.H., Taunusstein-Neuhof (Germany, F.R.).
For primary bibliographic entry see Field 2K.
W91-04999

SPRING GROWING PERIOD AS A REGULATOR OF THE SIZE OF THE SMOLT RUN IN TROUT (SALMO TRUTTA).

Department of the Marine, Castleknock (Ireland). Fisheries Research Centre.
E. Fahy.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 325-330, September 1990. 1 fig, 3 tab, 12 ref.

Descriptors: *Fish migration, *Ireland, *Sea trout, *Seasonal variation, Fish growth, Fish physiology, Fish populations, Fisheries, Smolt.

Arising from research in the Waterville, Co Kerry area, sea trout (Salmo trutta) fishery, as many as 71% of 2 year smolts (the largest smolt class) are shown to make an average of 3.6 cm growth in length (an addition of 19% on length at the end of the last premigration winter) in the spring of their first migration to sea. These 'B' type increments are critical in bringing the fish to threshold size for migration. Both incidence and amount of B growth are shown to be regulated by growing conditions in the spring. The strength of the smolt exodus also correlates with spring growing conditions. A suitable formulation for the expression of the B type growth increment is sought and proposed as an indicator of recruitment to sea trout populations. (Author's abstract)
W91-05000

ESTIMATION OF FISH PRODUCTION AND POTENTIAL YIELD IN LAKE MANZALA, EGYPT.

Cairo Univ., Giza (Egypt). Dept. of Zoology.
H. M. Bishai, and M. T. Khalil.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 331-337, September 1990. 3 fig, 14 ref.

Descriptors: *Fish populations, *Lake Manzala, *Lake fisheries, *Limnology, *Productivity, Biomass, Drainage water, Egypt, Fisheries, Nutrients.

According to yield models analyzed (Morphoedaphic Index and primary production covariates), which have been used in many African and North American lakes, the estimated existing open water fish yield in Lake Manzala is about 600 kg/ha (i.e. 60,000 t/yr). It is at or near potential and is considered in the high enrichment category. During 1920-1929, the estimated fish production of Lake Manzala was about 70 kg/ha which was considered a low enrichment category, as are the present northern and western subsectors of the lake. During 1962-1966, Lake Manzala belonged entirely to the moderate enrichment category where the estimates fish production was about 190 kg/ha, as does the eastern sector of present day Lake Manzala. The southern sector of Lake Manzala (23% of the lake area) is considered to be an example of ultra enrichment, where the estimated potential yield is about 2000 kg/ha. This is mainly attributed to the nutrient loading of the southern drains that enter into the latter basin which is relatively isolated from the rest of the lake geographically. Over the long term, and based on existing nutrient input to fish yield relationships, it is estimated that increased nutrient loading from drain water sources to the lake may elevate its existing yield by 60,000 t to 80,000 t by the year 2000 (i.e., fish yield could be increased to 120,000 to 140,000 t/yr). (Author's abstract)
W91-05001

ECOLOGY OF NERITINA GLABRATA IN LAGOS LAGOON, NIGERIA.

Ibadan Univ. (Nigeria). Dept. of Zoology.
E. A. Ajao, and S. O. Fagade.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 339-350, September 1990. 9 fig, 1 tab, 17 ref.

Descriptors: *Coastal waters, *Gastropods, *Lagos Lagoon, *Salinity, Lagoons, Nigeria, Organic matter, Productivity, Seasonal variation, Sediment contamination, Silt.

A study of the seasonal and spatial distribution of the population of Neritina glabrata Sowerby in Lagos Lagoon, Nigeria was conducted from February 1985 to December 1986. The gastropod occurs in large densities in the shallow shoal sands of the north and north-eastern rims of the lagoon. Its distribution and abundance were shown to be dependent on the silt content, total organic matter and contamination of the sediment. Eggs developed during the low salinity months between April and December but breeding occurred during the high salinity season (Jan-March). Annual production was estimated as 0.086 and 0.258 g C/sq m/yr (formalin fixed ash free dry weight) respectively at two sampling sites, and ratio between the annual

production and mean biomass varied between 1.29 and 2.11. (Author's abstract)
W91-05002

INTERACTION BETWEEN THE EFFECTS OF SUBSTRATUM, VELOCITY AND LOCATION ON STREAM BENTHOS: AN EXPERIMENT.
Monash Univ., Clayton (Australia). Dept. of Botany.
For primary bibliographic entry see Field 2E.
W91-05003

METHANE EMISSIONS FROM THE FLORIDA EVERGLADES: PATTERNS OF VARIABILITY IN A REGIONAL WETLAND ECOSYSTEM.
National Aeronautics and Space Administration, Hampton, VA. Langley Research Center.
D. S. Bartlett, K. B. Bartlett, J. M. Hartman, R. C. Harris, and D. I. Sebacher.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 4, p 363-374, December 1989. 3 fig, 2 tab, 34 ref.

Descriptors: *Everglades, *Florida, *Limnology, *Methane, *Methanogenesis, *Remote sensing, *Wetlands, Aquatic habitats, Distribution patterns, Model studies, Soil gases, Spatial distribution, Water level fluctuations.

The spatial variability of methane flux was examined within a large regional wetland system, the Florida Everglades. Unit area methane flux to the atmosphere from water-saturated Everglades environments, measured in situ, varied over more than an order of magnitude (4.2 to 81.9 mg CH4/sq m/d) depending on which habitat component of the ecosystem was sampled. Use of high resolution, orbital remote sensing data helped reduce uncertainty in the emission inventory of the Everglades by directing in situ sampling efforts to important habitat types and by providing a means for calculating area-weighted mean flux for the system as a whole. The results indicated that spatial variability in flux within a major wetland ecosystem can introduce significant uncertainty in extrapolations to larger areas, even if the extent of the major ecosystem itself is well known. The results also suggested that the response of total ecosystem flux to changing water level is not a linear function of flooded area, but is damped, with regional flux at lowered water levels decreasing proportionally less than flooded area. (Feder-PTT)
W91-05017

MECHANISMS CONTROLLING CU, FE, MN, AND CO PROFILES IN PEAT OF THE FILSON CREEK FEN, NORTHEASTERN MINNESOTA.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2K.
W91-05050

COMPREHENSIVE SURVEY OF THE HYPERTROPHIC LAKE TUUSULANJARVI: NUTRIENT LOADING, WATER QUALITY AND PROSPECTS OF RESTORATION.
Keski Uusimaa Inter-Municipal Corp. for Water Pollution Control, Kerava (Finland).
For primary bibliographic entry see Field 5G.
W91-05061

PALEOLIMNOLOGICAL INVESTIGATION OF THE EUTROPHICATION HISTORY OF LAKE TUUSULANJARVI, SOUTHERN FINLAND.
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-05062

OCCURRENCE OF VEGETATED BUFFER ZONES ALONG BROOKS IN THE CATCHMENT AREA OF LAKE TUUSULANJARVI, SOUTH FINLAND.
For primary bibliographic entry see Field 5G.
W91-05064

SEASONAL FLUCTUATIONS IN THE CHEMISTRY OF SMALL FOREST LAKES IN SOUTHERN FINLAND WITH SPECIAL REFERENCE TO ACIDITY.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
L. Arvola, T. R. Metsala, A. Simila, and M. Rask.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 71-79, 1990. 9 fig, 2 tab, 41 ref.

Descriptors: *Acid rain effects, *Finland, *Forest watersheds, *Lakes, *Seasonal variation, *Water chemistry, Acid lakes, Acidity, Alkalinity, Humic substances, Hydrogen ion concentration, Nitrogen, Phosphorus, Sampling, Snowmelt, Spatial variation.

Seasonal variability of pH, alkalinity, and other chemical constituents was studied in 27 small forest lakes (Finland) with varying humic content. The lakes were sampled seven times during one year. Also, during March-May, both temporal and vertical variability of pH and alkalinity of one small humic lake (Lake Nimeton) were followed more intensively. Typically, low pH and alkalinity coincided with snow and ice melt in spring and high pH with high primary productivity. The smallest seasonal variations in pH and alkalinity were found in the most acid lakes, whereas the highest variations were found in those lakes having winter pH of 5-6. No distinct difference in pH between clear and humic lakes was detected, but the average concentrations of cations, phosphorus, and nitrogen were higher in humic lakes than in clear ones. Along a chain of lakes a slight increase in pH and alkalinity and a decrease in phosphorus and nitrogen were evident from top to bottom. Rapid fluctuations in water chemistry recorded in this study stress the importance of short interval sampling if the patterns of water quality of small forest lakes are studied. (Author's abstract)
W91-05066

MICROPHYTOBENTHIC CELL DENSITY AND SPECIES COMPOSITION IN THE SURFACE SEDIMENT IN A SHALLOW BRACKISH-WATER BAY (GULF OF FINLAND).
Uppsala Univ. (Sweden). Inst. of Ecological Botany.
P. Snoeijs, E. Leskinen, K. Sundback, M. Kuylenstierna, and A. Witkowsky.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 103-114, 1990. 3 fig, 1 tab, 54 ref, append.

Descriptors: *Benthos, *Gulf of Finland, *Laboratory methods, *Sediments, Biomass, Comparison studies, Diatoms, Microscopy, Population density, Species composition, Viability.

Cell density and species composition of the microphytobenthos (mainly consisting of diatoms) were investigated in the surface sediment of a shallow brackish-water bay in the Gulf of Finland. Samples from four proximate sites (depth 1.5 m) were analyzed. Two methods were combined: (1) living cells were quantitatively counted by using ultrasonication and epifluorescence microscopy, and (2) oxidized diatom frustules were counted quantitatively on permanent microscopic slides and corrected for the percentage of dead cells. Cell densities obtained by these two methods varied similarly between the different sampling sites, but the frustule counts gave values that were on average 3.3 times higher than the living-cell counts. This discrepancy between the results of the two methods was explained by the fact that both methods have shortcomings. Frustule counts include both living and dead diatoms, which are difficult to separate; ultrasonication may destroy part of the cells and not detach others from the sand grains; fluorescent chloroplasts may be shaded by particles. Generally, counting living cells leads to under-estimation and counting frustules to over-estimation of the actual density of viable diatom cells in the surface sediment. Both methods in combination, and well calibrated with each other, offer the possibility to simultaneously assess community composition and cell density (which may be transformed to biomass). No large differences in species composition occurred between sampling sites, but the small between-site variation that did occur possibly could have been related to sediment characteristics and macrophytic abundance. The dominant species in the samples were typical small, sediment-associated diatoms such as Achnanthes delicatula, Achnanthes lemmermannii, Amphora pediculus, Cocconeis cf. diminuta, Fragilaria cf. elliptica, Fragilaria cf. pinnata, and Navicula seminulum. (Author's abstract)
W91-05067

PRELIMINARY OBSERVATIONS ON THE EFFECTS OF LIMING TO THE FISH POPULATIONS OF SMALL ACIDIC LAKES IN SOUTHERN FINLAND.
Finnish Game and Fisheries Research Inst., Helsinki. Fisheries Div.
For primary bibliographic entry see Field 5G.
W91-05068

ANTICIPATED EFFECTS OF CLIMATE CHANGE ON FRESHWATER FISHES AND THEIR HABITAT.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 2B.
W91-05164

POTENTIAL EFFECTS OF GLOBAL WARMING ON NATIVE FISHES OF THE SOUTHERN GREAT PLAINS AND SOUTHWEST.
Oklahoma Univ., Kingston. Biological Station.
For primary bibliographic entry see Field 2B.
W91-05166

POST-SPATE DEVELOPMENT OF EPILITHIC ALGAL COMMUNITIES IN DIFFERENT CURRENT ENVIRONMENTS.
Louisville Univ., KY. Dept. of Biology.
C. G. Peterson, and R. J. Stevenson.
Canadian Journal of Botany CJBOAW, Vol. 68, No. 10, p 2092-2102, 1990. 7 fig, 1 tab, 72 ref. NSF Grant No. R118610671.

Descriptors: *Species composition, *Flash floods, *Diatoms, *Water currents, *Algal growth, *Stream biota, Slow current, Fast current, Algae, Zygnematalean mats, Nutrient concentrations.

Development of epilithic algal communities was monitored in fast (29 cm/sec) and slow current (12 cm/sec) outdoor experimental stream channels for 33 days following a simulated spate. Disturbance reduced diatom densities in both current regimes to equal levels, but recovery was more rapid in slow current. Maximum algal abundances, which seemed to reach carrying capacity in both current environments, were lower in fast current than in slow. The percentage of live cells in diatom assemblages decreased during community development. The small, monoraphid diatom Achnathes minutissima Kutz. dominated communities in both current regimes from 0 to 12 days, principally because of its persistence on substrata through disturbance. Post-spate diatom accumulation was more rapid in slow current, presumably due to higher cell export in fast current. Differences in community structure between current regimes during early (0-6 day) recovery were attributed to differences in attachment strength and growth form of persistent species. In both current regimes, initial dominance by A. minutissima shifted to dominance by Synedra species and dense, floating mats of zygnematalean green algae. Zygnematalean mats enhanced diatom deposition and probably reduced water-column nutrient concentrations, altered light availability, and increased habitat heterogeneity. Zygnematalean proliferation affected diatom succession in slow but not in fast currents, suggesting that autogenic changes were more pronounced in slow-current habitats. (Author's abstract)
W91-05190

DIFFERENTIAL TOLERANCES AMONG SOFT-WATER MACROPHYTE SPECIES TO ACIDIFICATION.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5C.
W91-05191

DISTRIBUTION OF LONG-LIVED RADIONUCLIDES IN AN ABANDONED REACTOR COOLING RESERVOIR.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5B.
W91-05200

HYDROLOGIC INFLUENCES, DISTURBANCE, AND INTRASPECIFIC COMPETITION IN A STREAM CADDISFLY POPULATION.
California Univ., Berkeley. Dept. of Entomological Sciences.
J. W. Feminella, and V. H. Resh.
Ecology ECOLAR, Vol. 71, No. 6, p 2083-2094, December 1990. 3 fig, 6 tab, 76 ref.

Descriptors: *Aquatic insects, *Hydrological regime, *Caddisflies, *Population dynamics, *Population density, Competition, Larval growth stage, Rainfall, Flood peak, Seasonal variation, Algal biomass.

Field observations and experiments were conducted in Big Sulphur Creek, Sonoma County, California, over a 4-yr period to examine the relationship between wet-season hydrologic disturbance and subsequent density of late-instar Helicopsyche borealis and assess the impact of competition on this population under different hydrologic disturbance regimes. Using multiple regression, a strong relationship was found between spring density of late instar and various hydrologic parameters of the preceding wet season during the study period, 1985-1988. Of eight hydrologic parameters used as indices of disturbance, total wet season rainfall and peak discharge together accounted for 42% of the variation in H. borealis density. Densities of middle instars of the next generation in summer were unrelated either to the preceding wet season hydrologic regime or late-instar densities of the previous generation. Field experiments conducted in enclosures using larval densities that corresponded to harsh, moderate, and mild wet-season hydrologic regimes indicated that: (1) increases in larval density had a strong negative effect on algal biomass (as chlorophyll a); (2) larval density was negatively correlated with the proportion of larvae that pupated, and with pupal size; and (3) the high density treatment produced smaller adult males and females, and lower fecundities than intermediate and low densities. In most years, storms and associated disturbance reduced late-instar density below levels of larval competition; this counteracts earlier competition among middle instars that occurs during low-flow conditions. In drought years, however, densities may not be reduced as severely by wet-season storms and competition may continue until emergence. In this case, competition can reduce individual fitness, but because of high adult densities during these mild-disturbance conditions the reproductive capacity of the population is unaffected. (Medina-PTT)
W91-05202

PHYSICAL AND CHEMICAL ANALYSIS OF EGYPT'S WADI EL-RAIYAN MAN MADE LAKES.
Texas Southern Univ., Houston. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W91-05205

LABORATORY AND IN-SITU SEDIMENT OXYGEN DEMAND DETERMINATIONS FOR A PASSAIC RIVER (NJ) CASE STUDY.
New Jersey Agricultural Experiment Station, New Brunswick.
For primary bibliographic entry see Field 5B.
W91-05208

EFFECTS OF ALUM TREATMENT ON PHOSPHORUS DYNAMICS AND PHYTOPLANKTON RESPONSE IN EAU GALLE RESERVOIR, WISCONSIN.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5G.
W91-05271

FLOODS THREATENING KASHMIR WETLANDS.
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 2E.
W91-05385

NATURE OF DISSOLVED ORGANIC MATTER IN THE DRAINAGE BASIN OF A BOREAL HUMIC RIVER IN NORTHERN FINLAND.
Oulu Univ. (Finland). Dept. of Botany.
K. Heikkinen.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 649-657, Oct-Dec 1990. 4 fig, 6 tab, 56 ref.

Descriptors: *Cold regions, *Dissolved organic carbon, *Dissolved organic matter, *Finland, *Humic substances, *Peat bogs, *Stream chemistry, *Wetlands, Colloids, Drainage effects, Iron compounds, Phosphorus compounds.

The nature of dissolved organic matter (DOM) in river, brook, and peat mining water in the drainage basin of the humic Kiiminkijoki River, located in an area of minerotrophic peatlands in northern Finland in the boreal region, was studied by gel filtration. Special emphasis was paid to changes in the nature of high molecular weight organic Fe-P colloids that result from peat mining. The river water is organically colored, with high organic matter and Fe concentrations. High apparent molecular weight (HAMW) organic colloids are important for the transport of Fe and P in the basin. The gel filtration data suggest that the DOM in the water consist mainly of fulvic acids (FA), although humic acids (HA) are also important. The proportion of dissolved organic carbon (DOC) and Fe in the HAMW organic colloids increases with increasing DOC and iron concentrations in river water. The apparent molecular weight of the DOM is higher in the lakes in the area of ombrotropic peatlands in southern Finland. Color in this humic water increases with DOC and Fe concentrations. The effect of Fe on water color values can be seen in filtered ($<$ 1.2 micron) river water and in all gel filtration fractions. The results indicate an increase in the mobilization of HAMW organic Fe-P colloids in the peatlands of the area following drainage and peat mining. The average ratio of Fe to DOC in the HAMW organic fraction is higher in peat mining water than in the Keihasoja brook in a natural peaty area. It is possible that the Fe to DOC ratio in these colloids transported in the river increases following drainage and peat mining, especially under low flow conditions in the summer. This may lead to gradual changes in the detritus food webs in the river ecosystem. (Author's abstract)
W91-05394

STUDIES OF A SUBARCTIC COASTAL MARSH. III. MODELLING THE SUBSURFACE WATER FLUXES AND CHLORIDE DISTRIBUTION.
Memorial Univ. of Newfoundland, St. John's. Dept. of Geography.
J. S. Price, and M.-K. Woo.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 1-13, December 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *Advection, *Coastal marshes, *Groundwater movement, *Mathematical models, *Model studies, *Saline-freshwater interfaces, *Wetlands, Beach profiles, Finite difference methods, Finite element method, Fluctuations, Saline water, Salinity, Simulation analysis, Solute transport, Water chemistry.

A two-dimensional advection dispersion model of solute transport was used to simulate the long-term changes in the chloride distribution of the young isostatically raised beach ridge and depression sequences in a James Bay coastal marsh. The USGS-SUTRA model reproduces the hydraulic conditions in the wetland, causing recharge of freshwater to the ridges and discharge of saline water to the inter-ridge depressions, demonstrating the importance of vertical water fluxes of water and chloride. Even though water velocities are very low, molecular diffusion alone cannot explain the observed chloride distribution. Imposing the characteristics of a frozen surface during winter eliminated the vertical fluxes, and doubled the time required for the simulated chloride distribution to match the field data. The model correctly predicts the observed pattern of suppressed salinity beneath the ridges and a general decrease of salinity with distance inland. The results are useful in understanding the processes which operate in the first 100 years of marsh development. (See also W89-06459 and W89-06460) (Author's abstract)
W91-05427

NUTRIENTS AND PHYTOPLANKTON IN THE GULF OF LIONS, NORTHWESTERN MEDITERRANEAN.
Consejo Superior de Investigaciones Cientificas, Gerona (Spain). Centro de Estudios Avanzados de Blanes.
A. Cruzado, and Z. R. Velasquez.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 931-942, 1990. 7 fig, 1 tab, 21 ref.

Descriptors: *Gulf of Lions, *Mediterranean Sea, *Nutrients, *Phytoplankton, Coastal waters, Diatoms, Discharge rates, Freshwater, Population density, Primary productivity, Saline-freshwater interfaces, Seasonal distribution, Seawater, Stream discharge.

The mostly oligotrophic character of the Mediterranean Sea is altered drastically in areas receiving outflow from large rivers. The Gulf of Lions, receiving discharges from the Rhone River, has nutrient and phytoplankton concentrations much higher than the adjacent open northwestern Mediterranean Sea. A surface layer of freshwater, with thickness that varies with the meteorological conditions between 2 and 40 m, overlies the deeper open seawater and is advected onto the shelf and influences an area that covers the eastern half of the Gulf of Lions. Most of the waters affected by the river discharges show property relationships indicating conservative behavior, with very little or no loss of nutrients through phytoplankton uptake, particularly in winter. Phytoplankton populations in winter are sparse, with maximum densities just above and below the boundary between the freshwater and seawater. Diatoms are the main group of organisms, although dinoflagellates, coccolithophorids and cyanobacteria are abundant. Small heterotrophs (ciliates, tintinnids, etc.) are also abundant and are positively correlated with the diatoms. A water balance mode links the river discharge to the advective fluxes of water and nutrients and the primary productivity supported by these fluxes is estimated. (Author's abstract)
W91-05455

FORMATION, COLONIZATION AND FATE OF FLOATING SUDDS IN THE MAUNACHIRA RIVER SYSTEM OF THE OKAVANGO DELTA, BOTSWANA.
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Botany.
K. Ellery, W. N. Ellery, K. H. Rogers, and B. H. Walker.
Aquatic Botany AQBODS, Vol. 38, No. 4, p 315-329, December 1990. 5 fig, 1 tab, 32 ref.

Descriptors: *Aquatic plants, *Botswana, *Colonization, *Plant growth, *Sudds, *Wetlands, Aggregates, Floating mats, Organic matter, Seasonal variation.

The term 'sudd' is presently used to describe any floating vegetation mat in a wetland system. Two types of sudds, organic and plant sudds, form in the back-swamp communities of the Maunachira river system in the Okavango Delta, Botswana. The seasonal pattern of organic sudd formation, their permanence, plant species colonization and the effect of disturbance on sudd movement were investigated. Floating organic sudds, which form as a result of gas production in the benthic detrital aggregate, provide an exposed surface for plant colonization. The sequence of establishment of plants was found to be determined largely by the input of propagules from the surrounding communities after exposure. The organic sudds of the

Maunachira back swamps tend to form, or rise to the surface, during the summer and sink again during the winter months. This is probably the result of seasonal changes in the rate of microbial gas production. The sudds are extremely mobile and, as a result of wind action, bank up on the leeward side of the water body. Rates of encroachment across open water are variable and relatively slow (0.02-0.17 m/year). A more rapid rate of encroachment (1.46 m/year) is achieved in plant sudd formation by the vegetative growth of the sudd-forming sedge Pycreus nitidus (Lam.) J. Raynal. This species requires physical support for stolon extension which is provided by unconsolidated benthic detrital aggregations or the submerged plant Websteria confervoides (Poir.) Hooper which forms a base mat near the water surface. Both the organic and the plant sudds play an important role in determining community processes as they serve to provide a surface for the establishment of short emergent species which would otherwise not become established. (Agostine-PTT)
W91-05485

TOXICITY OF CHROMIUM (VI) TO PHOTOSYNTHESIS OF THE PHYTOPLANKTON ASSEMBLAGE OF LAKE ERIE AND THE DIATOM FRAGILARIA CROTONENSIS KITTON.
Windsor Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-05486

INFLUENCE OF TEMPERATURE, LIGHT AND NUTRIENT LIMITATION ON ANTHOCYANIN CONTENT OF POTAMOGETON GRAMINEUS L.
Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.
D. F. Spencer, and G. G. Ksander.
Aquatic Botany AQBODS, Vol. 38, No. 4, p 357-367, December 1990. 3 fig, 7 tab, 14 ref.

Descriptors: *Aquatic plants, *Light effects, *Limnology, *Macrophytes, *Nutrients, *Pigments, *Potamogeton, *Temperature effects, Anthoeganin, California, Canals, Chlorophyll, Iron, Nitrogen, Phosphorus, Sediment analysis.

The factor (or factors) responsible for the development of the reddish-brown color by Byrnes Canal (in northern California) populations of Potamogeton gramineus L. was investigated. Field measurements and experiments designed to assess the roles of nutrient limitation, temperature and light in influencing the anthocyanin content of Potomogeton. gramineus were used. Results indicate the reddish-brown color was due to the presence of anthocyanin pigments. Tissue N and P were positively correlated with relative anthocyanin content. This suggests that anthocyanins did not accumulate due to N or P limitation. The anthocyanin content of P. gramineus grown in Byrnes Canal sediment, in the canal or in a greenhouse, was also unaffected by the addition of N, P, or N and P. Inorganic N concentrations in sediment samples from the Byrnes Canal were greater than 11 mg/kg, which was the level of inorganic N associated with increased anthocyanin production in a greenhouse study. The addition of Fe to Byrnes Canal sediments did not influence the relative anthocyanin content of P. gramineus grown in the canal. P. gramineus grown at 25 combinations of temperature (10,15, 25, 30 and 35 C) and light (8,15,22,58 and 189 micromole/sq m/s) in laboratory cultures exhibited greater changes in relative chlorophyll content than in relative anthocyanin content. In general, chlorophyll decreased sharply with increasing light while anthocyanin increased slightly. In the context of the light and temperature conditions prevalent in the Byrnes Canal, the reddish-brown color of P. gramineus appears to be the consequence of a decrease in relative chlorophyll content which unmasks the anthocyanins. (Author's abstract)
W91-05487

UPTAKE AND PHOTOSYNTHETIC UTILIZATION OF SEDIMENT-DERIVED CARBON BY PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STEUDEL.
Aarhus Univ. (Denmark). Botanical Inst.
H. Brix.
Aquatic Botany AQBODS, Vol. 38, No. 4, p 377-389, December 1990. 5 fig, 2 tab, 19 ref. Danish Natural Science Research Council, Project No. 11-4591.

Descriptors: *Carbon, *Limnology, *Marsh plants, *Photosynthesis, *Phragmites, *Roots, *Sediment chemistry, *Wetlands, Absorption, Carbon dioxide, Carbon radioisotopes, Interstitial water, Plant tissues, Rhizosphere.

Uptake of dissolved inorganic carbon (DIC) by roots and rhizomes of Phragmites australis (Cav.) Trin. ex Steudel and the subsequent internal transport and photosynthetic fixation were studied by adding C-14 labelled DIC to the rhizosphere interstitial water and then monitoring the C-14 activity in the interstitial water, lacunal air and the different plant tissues over the following 70 hours. Interstitial water C-14 carbon dioxide diffused into the lacunae of the root system and upward within the hollow stems of the plant. The amount of C-14 in all parts of the plant increased with time. The concentration was highest in the basal parts of the plant and decreased with distance from the substrate. Culm nodes and inter-nodes generally contained more C-14 than leaf sheaths and leaf laminae. The data suggest that sediment-derived carbon is predominantly transported via the lacunae to the aerial tissues as gaseous CO2 where it is fixed photosynthetically by green culms and leaf sheaths. Sediment-derived carbon constituted less than 1% of the amount of carbon fixed from the atmosphere by the aerial plant tissues. Apparently, the loss of root respiratory CO2 to the rhizosphere interstitial water quantitatively exceeded the root CO2 uptake. It is suggested that the utilization of sediment-derived carbon may be of significance for young sprouting roots. (Author's abstract)
W91-05489

GEOCHEMISTRY OF BLACK WATER IN SELECTED COASTAL STREAMS OF THE SOUTHEASTERN UNITED STATES.
Georgia Univ., Athens. Dept. of Agronomy.
K. H. Tan, R. A. Leonard, L. E. Asmussen, J. C. Lobartini, and A. R. Gingle.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 17/18, p 1999-2016, 1990. 6 fig, 4 tab, 31 ref.

Descriptors: *Blackwater streams, *Coastal streams, *Geochemistry, *Humic acids, *Water chemistry, *Water quality, Ammonia, Chemical analysis, Chlorides, Conductivity, Dissolved solids, Fulvic acids, Georgia, Ions, Little River, Nitrates, Nuclear magnetic resonance, Seasonal variation, Sodium, Spectroscopy, X-ray diffraction.

An investigation was conducted in a watershed formed by the tributaries of the Little River in South Georgia to study the nature of the humic and inorganic fractions of black water, and their influence on stream water quality. Large amounts of black colored water were sampled from 1983 to 1984 according to streamflow pattern in December, March, June and September. Measurements of air and water temperature and dissolved oxygen were made at the gaging sites, whereas water analysis for conductivity, Cl, NO3-N, NH4-N, P and total N, and other macro and micro-elements were conducted in the laboratory. Fulvic (FA) and humic acid (HA) were isolated from the water samples, and analyzed by infrared and 13-C NMR spectroscopy. Suspended clay from the water samples was collected and determined by x-ray diffraction analysis. The results showed that black water was characterized by low conductivity and low ion concentrations indicating satisfactory chemical quality. The Na content was half the amount of other rivers in the Southeastern United States, whereas the K content was similar to the world average. A seasonal fluctuation was noticed for Ca and Mg concentration. The increase of these ions during high streamflow in spring and summer was attributed to agricultural practices in the surrounding lands. Dissolved organic matter (DOM) concentration was highest in December during low streamflow. As DOM content decreased during high streamflow, water pH increased. A large part of the humified DOM was composed of fulvic acid, which was more aromatic in nature than soil-fulvic acid as determined by 13-C NMR. The suspended clay had a composition reflecting the clay mineralogy of Tifton soils in the surrounding uplands. It is believed that the Tifton soil, with its low activity clay and hence low cation exchange capacity,may not be able to buffer the effect of acid leaching of black water. (Author's abstract)
W91-05562

CHARACTERISTICS OF A MARSHLAND SOIL BUILT UP FROM MARINE AND PEAT MATERIAL.
Oldenburg Univ. (Germany, F.R.). Dept. of Biology.
L. Giani, and D. Giani.
Geoderma GEDMAB, Vol. 47, No. 1/2, p 151-157, August 1990. 2 fig, 2 tab, 25 ref. Deutsche Forschungsgemeinschaft Grants Ge-322/6-1 and Kr-333/23-1.

Descriptors: *Marine sediments, *Marshes, *Peat, Acidification, Germany, Humic acids, Hydrogen ion concentration, Organic matter, Soil chemistry, Soil properties, Sulfur compounds, Vegetation, Wetlands.

The marine marshland area seaward of the Sehestedter Aussendeichsmoor is built up from marine and moor peat material. Properties of the soil, which can be regarded as Humic Fluvisol, resulting from these unique sedimentation conditions were investigated. The site consists of areas dominated by Puccinella, areas showing Spartina and Salicornia, areas without vegetation and water-covered spots. Soil sampling was performed using a corer in an area covered by halophytes, near an area without vegetation. The sample site was representative of the very early stages of soil development in this area, characterized by an initial occurrence of a Gor horizon. Results indicate the Humic Fluvisol investigated is characterized by (1) sulfate depletion leading to intensive methanogenesis, (2) carbonate depleted soil sections and reduced pH values, and (3) high amounts of reduced sulfur compounds. With respect to further development, a quick acidification, leading to soil properties which are characteristic of older, but not currently seawater-influenced Humic Fluvisols, can be expected. It seems likely that these older Humic Fluvisols initially developed under marine conditions. (Agostine-PTT)
W91-05568

SHORT-RANGE ATMOSPHERIC TRANSPORT: A SIGNIFICANT SOURCE OF PHOSPHORUS TO AN OLIGOTROPHIC LAKE.
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.
J. J. Cole, N. F. Caraco, and G. E. Likens.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1230-1237, September 1990. 5 fig, 3 28 ref. NSF Grants No. BSR 85-16897 and BSR-89-17962.

Descriptors: *Atmospheric circulation, *Dry deposition, *Limnology, *New Hampshire, *Nutrients, *Oligotrophic lakes, *Phosphorus, Rainfall, Seasonal distribution, Seasonal variation, Streamflow.

During summer stratification, particles transported by wind from surrounding forest were a major source of phosphorus into Mirror Lake, a small, oligotrophic lake in New Hampshire. These particles consisted largely of terrestrial insects, insect parts, and plant fragments of various sizes. This atmospheric fallout of phosphorus was greatest near the shoreline and decreased exponentially with increasing distance from shore. Integrated for the entire 15 ha lake, it represented an input of approximately 11 to 13 micromol phosphorus/sq m/day of lake surface in midsummer. The input of phosphorus from atmospheric fallout was highly significant in the summer phosphorus economy of the lake and was 50-fold to 70-fold greater than the input of phosphorus in either streamflow or rainfall in the same period. (Author's abstract)

W91-05578

ALKALINITIES OF MAINE LAKES: ARE THEY REALLY CHANGING.
Maine Univ., Orono. Dept. of Geological Sciences.
R. E. Stauffer.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1238-1257, September 1990. 4 fig, 7 tab, 49 ref. OWRT Grant 5-6-44942.

Descriptors: *Acid rain effects, *Alkalinity, *Lakes, *Maine, *Sulfates, *Water quality, *Wisconsin, Carbon dioxide, Carbonates, Error analysis, Hydrogen ion concentration, Hypolimnion, Mathematical models, Model studies, Oxygen deficit, Seasonal distribution, Temperature effects, Watersheds, Weather.

Alkalinity changes between 1938-1944 and 1985 were evaluated for Maine lakes in granitic watersheds. Modern (late summer 1985) Gran alkalinities for the hypolimnion were compared with historical alkalinities. With modern data for representative Maine lakes and historic (1932) data on dissolved gases reported for northern Wisconsin lakes, the apparent respiratory quotient relating change in carbon dioxide to change in oxygen is 0.92. A mathematical model yields alkalinity estimates with a relative root-mean-square (RMS) error of approximately 15%. The alkalinities of the Maine lakes have increased by 15 to 50 microeq/L (>30%) since the original surveys. Lake alkalization is not the result of differences in antecedent weather, since abnormally dry weather predating 1942 would have acted to elevate alkalinities. It is hypothesized that the alkalinity increases in Maine lakes resulted from changes in atmospheric deposition of acidifying anions since World War II. The alkalinity changes registered by the Maine lakes over a 45-yr period are in general accord with predictions that might have been made based on fossil fuel usage inventories and the monitoring of benchmark streams in undisturbed forested catchments. The evidence suggests that New England has entered the sulfate 'washout stage' accompanying the early recovery phase in contemporary watershed models. (Brunone-PTT)
W91-05579

SULFUR CYCLE OF FRESHWATER SEDIMENTS: ROLE OF THIOSULFATE.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
B. B. Jorgensen.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1329-1342, September 1990. 5 fig, 38 ref. Danish Natural Science Research Council Grants 11.6308 and 11.6711.

Descriptors: *Biochemistry, *Limnology, *Sediment chemistry, *Sulfates, *Sulfur cycle, *Thiosulfates, *Water chemistry, Bacterial physiology, Brabrand Lake, Hydrogen sulfide, Odder River, Oxidation, Reduction, Sulfur bacteria.

The formation and pathways of thiosulfate in anoxic sediment were studied in the Odder River and Brabrand Lake, Denmark. Time-course experiments were done in slurries with four 35S tracers: SO4(2-), H2S, and thiosulfate with either the inner (oxidized) or the outer (reduced) S atom labeled. The two sediments gave similar results. Of all the thiosulfate consumed in Brabrand Lake sediment, 6% was oxidized, 50% was reduced, and 44% was disproportionated. Thiosulfate disproportionation is an inorganic fermentation in certain SO4(2-)-reducing bacteria by which the inner and outer S atoms are simultaneously transformed into SO4(2-) and 72% was converted into sulfide. Thiosulfate inhibited SO4(2-) reduction by 75%. The immediate products of anoxic sulfide oxidation were 34% SO4(2-) and 66% thiosulfate. Half of the oxidized sulfide was ultimately converted into SO4(2-) and half was recycled back to sulfide via thiosulfate. Two-thirds of the S in the sulfide-thiosulfide minicycle remained at an oxidation state of -2. Thiosulfate is thus a key intermediate in the sulfur cycle, both as a main product of anoxic sulfide oxidation and as a shunt between oxidative and reductive pathways. (Author's abstract)
W91-05583

DIFFUSIVE BOUNDARY LAYER OF SEDIMENTS: OXYGEN MICROGRADIENTS OVER A MICROBIAL MAT.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
B. B. Jorgensen, and D. J. Des Marais.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1343-1355, September 1990. 9 fig, 20 ref. Danish Natural Science Research Council Grant 81.5919.

Descriptors: *Boundary layers, *Diffusion, *Flow velocity, *Limnology, *Microorganisms, *Oxygen gradients, *Saline ponds, *Sediment chemistry, *Sediment-water interfaces, Oxygen requirements, Oxygen uptake, Surface topography.

Oxygen microelectrodes were used to analyze the distribution of the diffusive boundary layer (DBL) at the sediment-water interface in relation to surface topography and flow velocity. The sediment, collected from saline ponds, was covered by a microbial mat that had a high oxygen consumption rate and well-defined surface structure. Diffusion through the DBL constituted an important rate limitation to the oxygen uptake of the sediment. The mean effective DBL thickness decreased from 0.59 to 0.16 mm as the flow velocity of the overlying water was increased from 0.3 to 7.7 cm/sec (measured 1 cm above the mat). The oxygen uptake rate concurrently increased from 3.9 to 9.4 nmol/sq cm/min. The effects of surface roughness and topography on the thickness and distribution of the DBL were studied by three-dimensional mapping of the sediment-water interface and the upper DBL boundary at 0.1 mm spatial resolution. The DBL boundary followed mat structures that had characteristic dimensions > 1/2 DBL thickness but the DBL had a dampened relief relative to the mat. The effective surface area of the sediment-water interface and of the upper DBL boundary were 31 and 14% larger, respectively, than a flat plane. Surface topography thereby increased the oxygen flux across the sediment-water interface by 49% relative to a one-dimensional diffusion flux calculated from the vertical oxygen microgradients. (Author's abstract)
W91-05584

NITROGENOUS NUTRIENT TRANSFERS IN OYSTER PONDS: ROLE OF SEDIMENT IN DEFERRED PRIMARY PRODUCTION.
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
J. M. Sornin, Y. Collos, D. Delmas, M. Feuillet-Girard, and D. Gouleau.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 15-22, December 15, 1990. 6 fig, 2 tab, 37 ref. PIREN-CNRS Grant 82-636.

Descriptors: *Cycling nutrients, *Nitrogen cycle, *Nutrient transport, *Oyster ponds, *Primary productivity, *Sediment chemistry, Algal growth, Ammonia, Biomass, Dissolved solids, Particulates, Phytoplankton, Seasonal variation, Tidal effects.

An oyster pond was studies that has a natural sediment bottom and in which water is changed only once or twice every month depending on tidal height. Between successive water renewals, the pond is a closed system, equivalent to a batch culture in which sinking and biodeposition of particulate matter are the only sources of organic matter to the bottom. Particulate organic matter enrichment of the sediment in winter is followed by intensive ammonification in summer with very limited nitrification. Seasonal nitrogen budgets involving particulate and dissolved phases show that in summer during batch mode periods, ammonium enrichment from the sediment to the overlying water is an order of magnitude higher than the initial nutrient supply in the feed water. This allows a large increase of the phytoplankton biomass. The term deferred primary production is suggested for this phenomenon because of the seasonal lag between particulate nitrogen deposition and dissolved nitrogen fluxes from the sediment. (Author's abstract)
W91-05589

EXCRETION OF ORGANIC CARBON BY PHYTOPLANKTON: ITS RELATION TO ALGAL BIOMASS, PRIMARY PRODUCTIVITY AND BACTERIAL SECONDARY PRODUCTIVITY IN THE BALTIC SEA.
Tvarminne Zoological Station (Finland).
R. Lignell.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 85-99, December 15, 1990. 8 fig, 6 tab, 80 ref.

Descriptors: *Algal growth, *Bacterial productivity, *Baltic Sea, *Biomass, *Finland, *Organic carbon, *Phytoplankton, *Primary productivity, Carbon cycle, Carbon radioisotopes, Carbon transport, Exudation, Gel filtration, Thymidine.

In 1985, algal biomass, primary productivity (incorporation of 14C, acidified water sample), excretion of organic matter (exudation), and bacterial secondary productivity were followed off the southwest of Finland, in the northern Baltic Sea. Molecular size fractionation of the dissolved (net) excreted organic carbon pool (EOC) was carried out by gel filtration. During the phytoplankton growth season the mean algal standing stock was 0.54 g C/sq m, and picoalgae (<2 microm) represented on average 17% of the total algal biomass. The primary production was 84.2 g C/sq m/yr. Annual EOC and total exudation (EOC plus bacterial uptake of exudates) values amounted to 4.6 and 7.1 % of primary production; at the same time, the net and total exudation averaged 7.5 and 10.8% of the current phytoplankton carbon biomass per day. Net bacterial production in the trophogenic layer was 12.1 g C /sq m/yr (tritiated thymidine method) or 38.4 g C /sq m/yr (dark carbon-14 labeled uptake); hence, assuming an assimilation efficiency of 50%, bacteria were able to satisfy 25 or 8% of their carbon demand via exudate uptake. Throughout the productive period, EOC consisted mainly of compounds of 300 to 600 daltons; larger compounds (1500 and > 10,000 daltons) were also observed. On the basis of the size of the excreted compounds, exudation probably took place via mediated transport across the algal cell membrane, rather than via passive leakage from the cell. (Author's abstract)
W91-05590

SEASONAL CONTRASTS IN DIURNAL CARBON INCORPORATION BY PHYTOPLANKTON SIZE CLASSES OF THE COASTAL PLUME OF CHESAPEAKE BAY.
Salisbury State Univ., MD. Dept. of Biological Sciences.
T. W. Jones, T. C. Malone, and S. Pike.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 129-136, December 15, 1990. 6 fig, 4 tab, 35 ref. NSF Grants 84-06526 and OCE 87-16909.

Descriptors: *Carbon cycle, *Chesapeake Bay, *Diurnal variation, *Estuarine environment, *Phytoplankton, *Seasonal variation, Biomass, Nutrient uptake, Periodicity, Polysaccharides, Primary productivity, Proteins.

Diurnal variations in patterns of carbon fixation by phytoplankton size classes in the coastal plume of the Chesapeake Bay were compared during seasonal extremes in freshwater flow and nutrient discharge. The diurnal mean chlorophyll-specific productivity (PB) for net and nanoplankton was correlated closely to temperature with the amplitude of diurnal variation in PB being minimal in April, higher in June, and maximal in August for both size classes. However, nanoplankton PB increased more rapidly and was significantly higher than netplankton PB in August. Biomass carbohydrate/protein ratios were consistently higher in netplankton than in nanoplankton and from April to August the magnitude of the ratio decreased for both size classes (2.35 to 1.23 and 0.85 to 0.58, respectively). Carbon incorporation into biochemical fractions was significantly correlated with productivity. Carbon incorporation into protein and polysaccharide exhibited greater diurnal periodicity during June and August when PB was correlated to solar radiation, respectively decreasing and increasing with increasing radiation during both months and in both size classes. Diurnal polysaccharide synthesis was highest relative to productivity in nano-

plankton during June when nanoplankton dominated the phytoplankton biomass, and likewise, net plankton polysaccharide synthesis was highest during August when net plankton dominated. Results suggest that these high diurnal rates of polysaccharide synthesis set the stage for higher rates of nocturnal protein synthesis and biomass production by nanoplankton during June and by net plankton during August. (Author's abstract)
W91-05591

POPULATION GROWTH AND EFFECTS OF NEMATODES ON NUTRIENT REGENERATION AND BACTERIA ASSOCIATED WITH MANGROVE DETRITUS FROM NORTHEASTERN QUEENSLAND (AUSTRALIA).
City Coll., New York. Dept. of Biology.
J. H. Tietjen, and D. M. Alongi.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 169-179, December 15, 1990. 4 fig, 4 tab, 36 ref. NSF Grant No. INT-8611445, PSC-CUNY Grant No. 667181, Australian Research Council Grant No. 86/0708.

Descriptors: *Bacteria, *Cycling nutrients, *Detritus, *Mangrove swamps, *Nematodes, *Nutrient concentrations, *Population dynamics, *Queensland, *Sediments, Ammonia, Bacterial growth, Correlation analysis, Nitrates, Nitrites, Nitrogen cycle, Phosphates, Seawater.

Two species of nematodes (Monhystera and Chromadorina) were isolated from mangrove sediments from northeastern Queensland and incubated for up to 40 days in 25 sq cm tissue culture flasks in filtered (0.20 microm Nuclepore) seawater containing fresh, 1 week, and 1 month aged Rhizophora stylosa and Avicennia marina detritus. Populations of both nematodes decreased in flasks containing aged detritus; by day 20 numbers of Monhystera and Chromadorina declined by an average of 75 and 46%, respectively. Neither species survived for more than 3 days on fresh R. stylosa leaves, which had high soluble tannin contents (> 11% dry wt). Only fresh A. marina leaves sustained increased nematode populations, perhaps as a result of a sufficiently high soluble nitrogen content combined with a lower tannin content (3.6%). Concentrations of dissolved inorganic nutrients (phosphate, nitrate, nitrite, ammonia), bacterial abundance and bacterial production were not significantly different in flasks containing aged detritus plus nematodes from those in flasks lacking nematodes. Bacterial abundances and production were higher in flasks with fresh A. marina litter and nematodes than in those without worms, but nutrient concentrations showed no differences. A significant positive correlation between bacterial and nematode abundances occurred in flasks with fresh A. marina litter; no correlations between the two existed for aged detritus. Minimal population densities of worms necessary to stimulate bacterial production and increase nutrient regeneration rates were not achieved on the types of detritus tested. Results from these experiments and field observations reported from other studies suggest that nematodes may not play a major role in the cycling of organic matter in tropical mangrove sediments. (Author's abstract)
W91-05594

PRIMARY PRODUCTION OF EPIPHYTIC ALGAE AND PHYTOPLANKTON IN THE LITTORAL ZONE OF LAKE KASUMIGAURA.
National Inst. for Environmental Studies, Tsukuba (Japan).
N. Takamura, T. Iwakuma, M. Aizaki, and M. Yasuno.
Marine Microbial Food Webs, Vol. 4, No. 2, p 239-255, 1990. 8 fig, 4 tab, 39 ref.

Descriptors: *Algal growth, *Lake Kasumigaura, *Limnology, *Littoral zone, *Phytoplankton, *Primary productivity, Biomass, Chironomids, Grazing, Light effects, Light intensity, Population density, Population dynamics, Seasonal variation, Temperature effects, Vegetation, Vegetation effects.

Primary production of epiphytic algae and phytoplankton was measured from May, 1984 to May, 1985 at both floating-leaved and emergent vegetations of hypertrophic Lake Kasumigaura, Japan. The maximum biomass of epiphytic algae was observed in the spring and winter. A sharp decline following spring can be explained by grazing by chironomids. The biomass remained low during the summer and autumn because of light limitation due to Microcystis bloom. The primary production of epiphytic algae was correlated significantly with the chlorophyll a amounts per sq m of epiphytes, but not with water temperature, light intensity, or nutrient concentrations. The values of primary production of epiphytic algae on the emergent and floating-leaved plants were 19 and 13 g C/sq m/year, respectively, which were only 2 and 3% of total primary production in the littoral zone, respectively. The epiphytic algal production in a hypertrophic lake was the lowest when compared with the previous reports, because of shading by phytoplankton or competition for nutrients with phytoplankton. (Author's abstract)
W91-05596

SILTATION OF RESERVOIRS IN AGRICULTURAL WATERSHEDS DETERMINED USING RADIOISOTOPE TECHNIQUES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2J.
W91-05658

GROUND-WATER DISCHARGE TO LAKES: FOCUSING IN EMBAYMENTS.
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
For primary bibliographic entry see Field 2F.
W91-05823

NUTRIENT TRAPPING EFFICIENCY OF A SMALL SEDIMENT DETENTION RESERVOIR.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
For primary bibliographic entry see Field 2J.
W91-05926

ALUMINIUM ACCUMULATION AND DISTRIBUTION IN THE FRESHWATER CLAMS (UNIONIDAE).
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
For primary bibliographic entry see Field 5B.
W91-05940

2I. Water In Plants

ASSESSMENT OF VEGETATION AND SOIL WATER REGIMES IN PARTIAL CANOPIES WITH OPTICAL REMOTELY SENSED DATA.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 2G.
W91-05032

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: I. ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
J. Eastham, and C. W. Rose.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 4, p 683-695, 1990. 6 fig, 4 tab, 26 ref.

Descriptors: *Forest management, *Pasture management, *Plant growth, *Plant-water relationships, *Root development, *Root distribution, Agricultural practices, Nutrients, Pastures, Plant physiology, Population density, Trees.

Water and nutrient uptake in plants depends largely on the concentration of roots expressed as root length or surface area per unit volume, and the distribution of this concentration in relation to the available resources. Planting density has been shown to affect the distribution and depth of tree roots, and pasture root production has been shown to decrease under shade. The effects of density on the distribution of tree and pasture roots under an agroforestry experiment were investigated by planting trees in a Nelder fan design with three different planting densities (2150, 304, and 82 stems per hectare). Proximity to trees and increase in tree density reduced pasture root growth, with the lowest concentrations of pasture roots occurring under the highest density of trees. Tree root systems were deeper and denser at high tree densities, although total length and mass of roots produced per tree decreased with increasing tree density. Tree root:shoot ratios increased as tree density decreased, due to greater root production at low tree densities. (See also W91-05162 and W91-05163) (Brunone-PTT)
W91-05161

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: II. WATER UPTAKE IN RELATION TO ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
J. Eastham, C. W. Rose, D. M. Cameron, S. J. Rance, and T. Talsma.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 4, p 697-707, 1990. 7 fig, 18 ref.

Descriptors: *Drought effects, *Trees, *Pastures, *Soil water, *Soil-water-plant relationships, *Root distribution, Plant growth, Forests, Agriculture, Transpiration, Soil horizons, Evaporation.

Patterns of water uptake throughout a drying period of approximately one year were investigated under trees and pasture at three tree densities in an agroforestry experiment, and related to tree and pasture rooting patterns and water use. A greater proportion of soil water was extracted from deep in the soil profile under the densely planted trees, due to the lower soil water contents in upper horizons and deeper and more dense rooting systems than at lower root densities. As the drought period progressed, the ratios of tree transpiration rate and pasture evaporation rate to equilibrium evaporation rate tended to decrease at each tree density as soil water contents in upper horizons decreased, and an increasing proportion of water was extracted from deeper soil horizons. At each tree density, the rate of water uptake per unit root length was lowest in surface soil horizons and tended to increase with increasing soil depth. The rate of water uptake per unit root length tended to increase with time in deeper, wetter soil horizons and decrease with time in surface soil horizons as soil water content decreased. (See also W91-05161 and W91-05163) (Author's abstract)
W91-05162

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: III. WATER UPTAKE IN RELATION TO SOIL HYDRAULIC CONDUCTIVITY AND ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 2G.
W91-05163

RESPONSE OF PEANUT TO MOISTURE STRESS AND IRRIGATION.
Indian Inst. of Tech., Kharagpur. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W91-05475

DETERMINATION OF EXCHANGEABLE SODIUM STATUS OF SALT-AFFECTED SOILS AND ITS RELATIONSHIP WITH GROWTH OF PLANTS.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils.

For primary bibliographic entry see Field 2K.
W91-05477

CATALASE, PEROXIDASE AND SUPEROXIDE DISMUTASE ACTIVITIES IN SEEDLINGS SUBMITTED TO INCREASING WATER DEFICIT.
Viterbo Univ. (Italy). Dipt. di Agrobiologia e Agrochimica.
M. Badiani, M. G. De Biasi, M. Colognola, and F. Artemi.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 90-102, 1990. 2 fig, 1 tab, 24 ref.

Descriptors: *Catalysts, *Enzymes, *Seedlings, *Soil-water-plant relationships, *Water deficit, *Water stress, Biochemical tests, Catalase, Dismutase, Lipids, Peroxidase.

The effect of increasing water deficit on some active O2 scavenging systems and their role during drought on the seedlings of six species were determined. The species studied were: Zea mays L., Calotropis procera L., Triticum aestivum L., Aegilops squarrosa L., Triticum monococcum L., and Triticum persicum (Percival) Vavilov. The specific activities of the enzymes superoxide dismutase (SOD), which catalyzes the disproportionation of superoxide anion to molecular oxygen and hydrogen peroxide; peroxidase (POD) and catalase (CAT), both involved in the elimination of hydrogen peroxide were measured. The activities of ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBPCase) and phosphoenolpyruvate carboxylase (PEPCase) were used as biochemical indicators of the onset of a metabolic impairment due to water deficit. The RuBPCase and PEPCase activities and protein contents progressively declined with increasing water deficit while POD and CAT activities were, in almost all the species, increased or maintained under the same conditions. SOD activity was increased or maintained in some species while it was decreased in others. The content of malondialdehyde, a peroxidative lipid breakdown product which was also monitored, was found in most cases to decline as water potential in the tissue decreased. The results confirm that water shortage can be regarded as an oxidative stress. This suggests that the tested scavenging activities could be increased in plant tissues as a defensive response to water-stress dependent formation of hydrogen peroxide and, in some species, superoxide. (Agostine-PTT)
W91-05478

SEASONAL CHANGES IN STANDING CROP OF ZOSTERA MUELLERI IN SOUTH-EASTERN AUSTRALIA.
Deakin Univ., Melbourne (Australia). Div. of Biological and Sciences.
For primary bibliographic entry see Field 2L.
W91-05488

ROOT GROWTH AND WATER UPTAKE BY WHEAT DURING DRYING OF UNDISTURBED AND REPACKED SOIL IN DRAINAGE LYSIMETERS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
W. S. Meyer, C. S. Tan, H. D. Barrs, and R. C. G. Smith.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 2, p 253-265, 1990. 6 fig, 3 tab, 18 ref, append.

Descriptors: *Lysimeters, *Plant growth, *Roots, *Soil properties, *Soil water, *Soil-water-plant relationships, *Wheat, Absorption, Agriculture, Available water, Drying, Soil types, Water deficit.

The availability of water to crops depends on both soil properties and root distribution. The dynamics of root development and water uptake in undisturbed and repacked clay soil were studied during increasing soil water deficit pre and post-anthesis to find how root distribution, soil type and plant development affect plant available water (PAW). Treatment were imposed in a randomized design with two replications. Volumetric water fraction was measured with a neutron probe, while root distribution was measured non-destructively using a series of horizontal perspex observation tubes. Soil modification affected the rate of downward root growth which changed little over time for undisturbed soil (6.7 to 13.6 mm/day) compared with the repacked soil (7.5 -42.9 mm/day). In the well-watered treatments root distribution was mostly above the 0.55 m depth in undisturbed soil, while there was a reasonably uniform vertical distribution in repacked soil. The rate of root growth in post-anthesis drying was 61% of that during pre-anthesis drying. The specific root water uptake rate (volume per unit root length per time) was linearly related to the relative root growth rate, indicating the importance of root growth in supplying water during soil drying. Estimated PAW values reflected effects of soil hydraulic properties, root distribution and a propensity to grow new roots during soil drying. (See also W91-05494) (Author's abstract)
W91-05493

ALTERNATIVE METHODS OF ESTIMATING WATER DEFICIT STRESS OF WHEAT GROWN ON UNDISTURBED AND REPACKED SOIL IN DRAINAGE LYSIMETERS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
C. S. Tan, W. S. Meyer, R. C. G. Smith, and H. D. Barrs.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 2, p 267-276, 1990. 6 fig, 2 tab, 25 ref.

Descriptors: *Agriculture, *Crops, *Evapotranspiration, *Lysimeters, *Soil structure, *Water deficit, *Wheat, Comparative studies, Cores, Estimating, Irrigation, Physical properties, Plant growth, Soil amendments, Stress, Temperature effects.

The effect of soil modification on changing the availability of water and the onset of crop water deficit stress in wheat was assessed during two drying periods. The wheat in the undisturbed and repacked core samples received one of three treatments: (1) well watered throughout; (2) a water deficit from mid-tilling to the end of anthesis (110 days from sowing) and then well watered; and (3) well watered then a water deficit period at the beginning of anthesis (96 days from sowing) until harvest. The deficit was induced by withholding irrigation water and excluding all rainfall with a movable raincover over the lysimeter area. Plant available water was defined as the difference in soil water content between the upper drained limit and the content at which evapotranspiration ceased owing to water deficit stress. The different methods of determining the onset of stress generally agreed with one another. Differences were either related to the different parts of the canopy measured or to different physiological processes measured. Because foliage temperature was continuously monitored, the dynamic development of stress in relation to increasing soil water deficit and root growth became evident. The allowable soil water deficit at the onset of stress was found to vary widely between soil treatments and the stage of crop growth at which deficit stress occurred. Physically modifying the soil increased plant available water by 80%. This resulted from both changes in amount of soil water stored and through a more uniformly distributed root system. Wheat growing in undisturbed soil was unable to adapt to post-anthesis stress, as frequent irrigations prior to anthesis concentrated root distribution in the upper layers. (See also W91-05493) (Agostine-PTT)
W91-05494

EFFECT OF SOLUTION PH, EXTERNAL CALCIUM CONCENTRATION, AND ALUMINUM ACTIVITY ON NODULATION AND EARLY GROWTH OF COWPEA.
Queensland Univ., Brisbane (Australia). Dept. of Agriculture.
A. K. Alva, C. J. Asher, and D. G. Edwards.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 2, p 359-365, 1990. 3 fig, 2 tab, 25 ref.

Descriptors: *Acidic soils, *Cowpea, *Legumes, *Plant growth, *Plant physiology, *Soil chemistry, *Soil-water-plant relationships, Aluminum, Calcium, Hydrogen ion concentration, Nodulation, Nutrients, Roots.

Effects of pH, calcium (Ca), and aluminum (Al) on the growth and modulation of cowpea (Vigna unguiculata) were studied in large-volume, dilute nutrient solutions. Ca concentrations over the range 0.05 mM to 2.5 mM, and pH over the range 4.5 to 5.5, had no significant effect on the growth of the host plant. However, the combination of low pH and low Ca delayed nodulation and strongly depressed nodule number and nodule dry weight. At the highest Ca concentration, effects of pH on nodule number were small and not significant, and effects on nodule weight, although significant, were much smaller than at the lowest Ca concentration. It was concluded that nodulation was more sensitive to low Ca and low pH than was host plant growth. At ph 4.5 and 0.5 mM Ca, Al delayed and depressed nodulation. An activity of 12.7 micro molar Al delayed nodulation by four days, and reduced nodule number and nodule dry weight drastically. At higher Al activities, nodulation was reduced to zero. The critical Al activities (10% reduction) were approximately 0.3 and 0.5 micro molar for nodule number and nodule dry weight. The dry weight of tops and roots showed a roughly linear decrease with increasing Al activity over the range 0 to 40 micro molar, both in inoculated plants supplied with 'starter nitrogen' and in plants supplied continuously with adequate mineral nitrogen. Critical Al activities for growth were in the range of 4 to 8 micro molar. It was concluded that nodulation was much more sensitive to Al than was host plant growth. Although cowpea is generally considered one of the more acid tolerant crop legumes, this was not the case with respect to cowpea cv. Vita 4. Cowpea cultivars appear to exhibit considerable variation with respect to their response to acid soil infertility. (Author's abstract)
W91-05495

PHYSIOLOGICAL ATTRIBUTES ASSOCIATED WITH DROUGHT RESISTANCE OF WHEAT CULTIVARS IN A MEDITERRANEAN ENVIRONMENT.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel).
A. Blum, and Y. Pnuel.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 5, p 799-810, 1990. 5 fig, 5 tab, 24 ref.

Descriptors: *Crop yield, *Drought resistance, *Plant physiology, *Wheat, Cultivars, Marine climates, Osmoregulation, Plant growth, Precipitation, Regression analysis, Seasonal variation, Statistical analysis.

Twelve spring wheat (Triticum aestivum L.) cultivars were planted in 16 trials which received seasonal rainfall (including irrigation) ranging from 230 to 755 mm/year. Under low rainfall conditions, drought stress occurred during the period of stem elongation when the ears grew. Grain filling was largely free of stress. Variation in precipitation explained 75% of the variation in mean yield among trials, and the main yield component responsible for yield reduction at low precipitation was ear number, as affected by tiller survival rate. The larger-yielding cultivars sustained a higher kernel number per ear in compensation for the reduced number of ears under stress. The yield stability of cultivars under low precipitation was defined by both the joint linear regression method and by the linear regression of yield on precipitation, both of which gave very similar predictions. The magnitude of the intercept of the latter regression was taken as an indicator of drought resistance in terms of yield. The variations among cultivars in this intercept was well explained by corresponding variations in osmotic adjustment, heat tolerance and canopy temperature. Grain filling from stem reserve mobilization was not important in this respect, evidently because grain filling was not subjected to drought stress in these trials. Early-heading cultivars had a relative yield advantage only when precipitation was less than about 300 mm

and grain yield was less than about 350 g/sq m. Both early heading and heat tolerance were positively correlated with osmotic adjustment across cultivars. It was therefore concluded that under these conditions the capacity for osmotic adjustment apparently allowed for ear growth under drought stress. (Author's abstract)
W91-05496

EFFECT OF LEAF NITROGEN AND WATER REGIME ON THE PHOTOSYNTHETIC CAPACITY OF KENAF (HIBISCUS CANNABINUS L.) UNDER FIELD CONDITIONS.
Commonwealth Scientific and Industrial Research Organization, St. Lucia (Australia). Div. of Tropical Crops and Pastures.
R. C. Muchow.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 5, p 845-852, 1990. 3 fig, 3 tab, 9 ref.

Descriptors: *Australia, *Fiber crops, *Field tests, *Kenaf, *Nitrogen, *Photosynthesis, *Plant growth, *Soil-water-plant relationships, Absorption, Agriculture, Clay loam, Crop yield, Irrigation, Leaves, Lighting, Soils, Water deficit.

To understand the influence of nitrogen (N) supply on the productivity of kenaf (Hibiscus cannabinus L.), the dependence of photosynthetic capacity measured as light-saturated leaf CO2 assimilation rate (CA) and crop radiation use efficiency (RUE), on specific leaf nitrogen (SLN) was examined under well watered conditions in the field. The field study was conducted at Katherine Research Station, N.T. (Australia) on Fenton clay loam, a well-drained red earth or Alfisol (USDA Soil Taxonomy: Oxic or Rhodic Paleustalf). A split-plot design was used with two irrigation regimes (wet and dry) as main plots and two levels of nitrogen application as subplots. Photosynthetic capacity increased hyperbolically with SLN and was most responsive at SLN values less than approximately 1.5 g/sq m. The relationship reached a plateau at a maximum CA of 37 micromole/sq m/s and a maximum RUE of 1.5 M/J. Increasing N application from 0 to 24 g N/sq m increased both RUE and SLN. Where ample N was applied, RUE and SLN were higher in those plots which previously experienced water deficit than in those that were always fully irrigated. The stimulation in growth following alleviation of water deficit was directly associated with the increase in SLN during water deficit. SLN varied according to differences in N uptake, the proportion of N allocated to leaves and the leaf area index. In particular, N application had much less effect on SLN and consequently RUE, than on N uptake, due to lower N partitioning to leaves and higher leaf area index where a high rate of N was applied. This quantitative information on the relationship between RUE and SLN is necessary to allow the prediction of crop performance under varying environmental conditions. (Author's abstract)
W91-05497

CORRELATION OF GROWTH OF THE ROOT AND SHOOT SYSTEMS OF WHITE CLOVER AFTER A PERIOD OF WATER SHORTAGE AND/OR DEFOLIATION.
Kyabram Research Inst. (Australia).
S. J. Blaikie, and W. K. Mason.
Australian Journal of Agricultural Research AJAEA9, Vol. 41, No. 5, p 891-900, 1990. 3 fig, 1 tab, 23 ref.

Descriptors: *Clovers, *Defoliation, *Legumes, *Plant growth, *Soil moisture deficiency, *Soil-water-plant relationships, *Water deficit, Correlation analysis, Greenhouses, Mathematical studies, Nutrients, Plant morphology, Roots, Soils, Stress.

Relationships were established between growth in root and shoot systems of white clover under conditions of stress such as soil water deficit and defoliation that typically occur in the field. Vegetative clones of white clover (Trifolium repens ev. Haifa) were grown in pots in a greenhouse for 6 weeks. The growth and development of the shoot and root systems were followed by destructive harvests at the outset and after 2, 3, 4, 5 and 6 weeks. Treatments comprised: (A) plants well watered with nutrient solution; (B) restricted watering; (C) well watered but defoliated after harvest three and allowed to regrow; and (D) restricted watering and defoliated. At the outset, all plants were of similar size (< 1.0 g DM), but by the end of the experiment, plant size ranged from 23.0 g DM in treatment A to 3.1 g DM in treatment D. For plants in the ideal treatment (A), there were strong linear correlations between the measured shoot and root parameters that were evident at all harvests. For plants growing in the stress treatments (B-D), these correlations were initially disrupted but were almost fully restored by the end of the experiment. In white clover, the growth and morphological development of roots and shoots are highly correlated. If this balance is disturbed, white clover responds to rapidly re-establish the original coordination. If these same relationships exist in the field soils, then higher shoot yields will only be possible if the growth of more roots is encouraged. (Author's abstract)
W91-05498

AGRONOMIC STUDIES ON THE PRODUCTIVITY OF KENAF (HIBISCUS CANNABINUS L. CV. GUATEMALA 4) UNDER RAINFED AND IRRIGATED CONDITIONS IN THE NORTHERN TERRITORY.
Commonwealth Scientific and Industrial Research Organization, St. Lucia (Australia). Div. of Tropical Crops and Pastures.
For primary bibliographic entry see Field 3F.
W91-05553

FIELD EVALUATION OF TISSUE CULTURE DERIVED SORGHUM FOR INCREASED TOLERANCE TO ACID SOILS AND DROUGHT STRESS.
Colorado State Univ., Fort Collins.
R. M. Waskom, D. R. Miller, G. E. Hanning, R. R. Duncan, and R. L. Voigt.
Canadian Journal of Plant Science CPLSAY, Vol. 70, No. 4, p 997-1004, October 1990. 5 tab, 19 ref.

Descriptors: *Acidic soils, *Drought stress, *Soil-water-plant relationships, *Sorghum, Arizona, Cultures, Field tests, Georgia, Hydrogen ion concentration, Plant tissues, Soil types, Soil water, Tissue analysis, Water deficit.

Plant tissue culture is being recognized as an important tool for generating useful variants for crop improvement. Experiments were conducted to determine if improved tolerance to acid soil and drought stress can be generated in Sorghum (Sorghum bicolor (L.) Moench) through tissue culture. Two environments were used to screen for enhanced field tolerance: (1) a low pH field in Griffin, Georgia for testing acid soil stress tolerance, and (2) an arid environment in Yuma, Arizona for testing drought stress tolerance. A population of 212 R1 sorghum lines from tissue cultures of Hegari and Tx430 were increased in 1986. Screening was then conducted in both environments during 1987. Selected entries which showed improved tolerance were advanced and re-tested during 1988. From this original population, four lines were identified as having improved acid soil tolerance and five lines were identified as having improved drought tolerance as compared to the non-regenerated checks. Three of these lines performed better than the non-regenerated checks under both acid soil and drought stress conditions. These results indicate that somaclonal variants for increased tolerance to environmental stresses can be generated in tissue culture and be selected under proper field conditions. (Author's abstract)
W91-05558

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: I. SEEDLING GROWTH AFFECTED BY SOIL WATER POTENTIAL.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05607

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: II. COMPARISON WITH FIELD EXPERIMENTS.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
A. Bouaziz, and L. Bruckler.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1838-1846, November/December 1989. 9 fig, 9 tab, 40 ref.

Descriptors: *Arid regions, *Mathematical models, *Model studies, *Plant growth, *Seedlings, *Soil water potential, *Soil-water-plant relationships, *Wheat, Field tests, Germination, Irrigation, Rainfall, Sensitivity analysis, Soil water, Temperature effects.

To improve the understanding and prediction of wheat (Triticum aestivum L.) emergence under dry conditions, a model describing wheat emergence in field conditions was developed. The proposed approach separates three basic processes from sowing to seedling emergence: seed imbibition and germination; root and seedling growth as influenced by soil water potential and temperature; and seedling emergence as affected by forces exerted by plant coleoptiles and soil surface structure. Previously developed models of each process were combined to predict seedling emergence. Field experiments consisting of irrigated and nonirrigated treatments and hand and mechanical seeding were used to validate the model. Model inputs included soil water content versus time, mean air temperature (daily basis), dry bulk density, the soil water content/water potential relationship, and soil surface structure. Sensitivity analysis showed a high sensitivity of the model to geometrical characteristics (root and coleoptile tortuosities and root angle) of seedlings under field conditions. Model prediction of germination and emergence were generally satisfactory, although errors occurred after irrigation or rainfall. Discrepancies were explained by changes in the mechanical properties and increasing impedance of the soil surface after wetting and subsequent drying, or by changes in soil temperature after wetting. Finally, simulations of germination and emergence for three climatic conditions (wet, intermediate, and dry), two sowing techniques (hand and mechanical), and two soil surface structures (fine and coarse) demonstrated the effects of those factors on emergence. In the most favorable case, 95% emergence occurred 15 days after sowing. In the most unfavorable treatment, 41% emergence occurred after 29 days. (See also W91-05607) (Author's abstract)
W91-05608

COTTON ROOT GROWTH AND SOIL WATER EXTRACTION.
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
W. L. Bland, and W. A. Dugas.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1850-1855, November/December 1989. 8 fig, 2 tab, 30 ref. BARD Grant No. I-399-81.

Descriptors: *Cotton, *Plant growth, *Root development, *Roots, *Soil water, *Soil-water-plant relationships, Crop yield, Lysimeters, Plant water uptake, Root distribution, Soil chemistry, Soil types, Spatial distribution, Subhumid climates.

The inherent productivity of many fine-textured soils depends on timely extraction of water stored deep in the profile. Growth of crop roots and their ability to extract water are of central importance to efficient utilization of these soil residues. The rate at which the soil volume was explored and water was extracted by cotton roots was observed in a fine-textured soil in a subhumid environment. Measurements of root growth and water extraction were made for 2 yr in a 2.3 m deep weighing lysimeter, 3.0 sq m in area and containing an intact core of a Frio tax-adjunct silty clay loam (fine, montmorillonite, thermic Cumulic Haplustoll). Water extraction was measured with neutron probes at 10 or 11 soil depths in the lysimeter at approximately 5 day intervals. Root length density was estimated at 7 day intervals by counting roots visible against clear observation tubes installed

horizontally in the lysimeter every 0.2 m between 0.5 and 2.1 m. Depth of rooting increased up to 35 mm/day for part of the season. Maximum root length density at 0.5 m was 1.5 and 0.8/sq cm in 1984 and 1985, respectively; at 2.1 m comparable values were 0.24 and 0.04/sq cm. When the lysimeter surface area was divided into six 0.5 sq m regions of soil, the coefficient of variation in root length density among the regions reached 100% both early and late in the season and both at 0.5 and 2.1 m. Crop rows did not affect the spatial distribution of root length density at depths measured. Growth of the root system required about 90 kg/ha/day for part of the season. Maximal water uptake rate per length of root was approximately 5 cu mm water/(mm root)/day and occurred at 1.7 to 1.9 m. Redistribution of dry matter invested in roots near the soil surface to deeper in the profile would probably increase total water extraction by the crop. (Author's abstract)
W91-05610

ESTIMATION OF TOTAL WATER CONSUMPTION OF SELECTED VEGETABLE CROPS IN THE SEMIARID AND HUMID REGIONS OF PUERTO RICO.
Puerto Rico Univ., Mayaguez.
For primary bibliographic entry see Field 3F.
W91-05632

WATER USE AND YIELD RELATIONSHIPS OF IRRIGATED POTATO.
Bangladesh Agricultural Research Inst., Joydebpur.
For primary bibliographic entry see Field 3F.
W91-05928

POTENTIAL ECONOMIC RETURNS TO IMPROVED IRRIGATION INFILTRATION UNIFORMITY.
Rhode Island Univ., Kingston. Dept. of Resource Economics.
For primary bibliographic entry see Field 3F.
W91-05934

EFFECT OF IRRIGATION SCHEDULING ON GROWTH, YIELD AND EVAPOTRANSPIRATION OF WHEAT IN SODIC SOILS.
Central Soil Salinity Research Inst., Karnal (India).
For primary bibliographic entry see Field 3F.
W91-05935

2J. Erosion and Sedimentation

ESTIMATING POROSITY OF PARTIALLY SATURATED SEDIMENTS.
Connecticut Univ., Groton. Marine Sciences Inst.
For primary bibliographic entry see Field 2G.
W91-04940

INFLUENCE OF ORGANIC MATTER FROM SOILS AND SEDIMENTS FROM VARIOUS ORIGINS ON THE SORPTION OF SOME CHLORINATED ALIPHATIC HYDROCARBONS: IMPLICATIONS ON K(OC) CORRELATIONS.
Tuebingen Univ. (Germany, F.R.). Inst. fuer Geologie und Palaentologie.
For primary bibliographic entry see Field 5B.
W91-04948

POTENTIAL OF BASING AN ECOLOGICAL TYPOLOGY OF AQUATIC SEDIMENTS ON THE NEMATODE FAUNA: AN EXAMPLE FROM THE RIVER RHINE.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nematology.
For primary bibliographic entry see Field 5A.
W91-04960

CONCENTRATION AND PARTIONING OF PARTICULATE TRACE METALS IN THE CHANGJIANG (YANGTZE RIVER).
Department of Marine Chemistry, Ocean Univ. of Qingdao, 5 Yushan Road, Qingdao 266003, P.R. China.
For primary bibliographic entry see Field 5B.
W91-04969

COMPREHENSIVE STUDY OF EAST FORK OF THE TOMBIGBEE: RESOURCE ISSUES BY THE CORPS OF ENGINEERS AND SOIL CONSERVATION SERVICE.
For primary bibliographic entry see Field 2E.
W91-05139

STABILITY OF FREE SURFACE SEDIMENT FLOW.
California Univ., San Diego, La Jolla. Inst. for Nonlinear Science.
P. G. Hjorth.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 11, p 20,363-20,366, November 15, 1990. 4 fig, 12 ref.

Descriptors: *Hydraulic properties, *Sediment transport, *Model studies, *Water level fluctuations, *Unsteady flow, *Yellow River, Sediment distribution, Sedimentation, *Mathematical models, Oscillatory waves, *Bingham plastics, Gravity flow, Surface instability.

Observations of unusual surface level oscillations on the sediment-laden Yellow River of China have led to the suggestion that the oscillations arise from a free surface instability peculiar to fluids having the constitutive relation of a Bingham plastic (i.e. possessing a finite yield stress). A model has been proposed in which free surface flows of Bingham plastics appear unstable at conditions for which the corresponding flow of clear water would be stable. Gravity driven Bingham plastics are, in fact, stable to free surface oscillations and consequently the Yellow River oscillations most likely do not stem from a simple surface instability. (Author's abstract)
W91-05170

ANTECEDENT WATER CONTENT AND RAINFALL ENERGY INFLUENCE ON SOIL AGGREGATE BREAKDOWN.
National Soil Erosion Lab., West Lafayette, IN.
C. C. Truman, J. M. Bradford, and J. E. Ferris.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1385-1392, September/October 1990. 6 fig, 10 tab, 29 ref.

Descriptors: *Antecedent moisture, *Soil erosion, *Soil stability, *Rainfall impact, *Rainfall, *Soil aggregates, Soil physics, Soil physical properties, *Soil properties, Agriculture, *Soil water, Matric potential, Particle size, Soil samples, Simulated rainfall.

Stability of soil aggregates under rainfall plays an important role in determining the magnitude of soil loss from cultivated fields. Soil and environmental factors controlling aggregate breakdown have yet to be fully defined. The influence of soil water conditions, aggregate size, and rainfall intensity and duration on aggregate breakdown in five soils ranging in texture from sandy loam to clay was determined. Using the wet-sieving method, median aggregate diameter values (D) were determined on both whole-soil samples (0 to 19 mm) and aggregate samples (2 to 4, 4 to 8, and 8 to 19 mm in diameter) at three water conditions (-0.5 kPa, -1.0 kPa, and air dried). A companion set of whole-soil samples was subjected to 64 and 127 mm/hour simulated rainfall for 5, 15, and 30 min, and a set of aggregate samples was exposed to 64 mm/hour simulated rainfall for 15 minutes; all samples were then wet sieved. Prewetting from air dry to -1.0 kPa matric potential provided the greatest increase in D values corrected for primary particle size for the wet-sieved Broughton clay also decreased the difference between Broughton D values obtained from whole-soil samples receiving rain plus wet sieving and D values of only wet-sieved samples by 1.4 mm for all rainfall energies. Changes in D corrected for primary particle size and difference between D values was due to rainfall energy were greatest for the air-dried Heiden clay. Rainfall energy (0.26 J/sq cm) decreased D corrected for primary particle size from 0.87 to 0.33 mm and increased the difference between D values from 0.32 to 0.54 mm. Results of this study indicate that an increase in initial water conditions increases the resistance of an aggregate to the forces of raindrops and flowing water, thereby lessening particle detachment (if other hydraulic variables are held constant). (Author's abstract)
W91-05184

QUANTIFICATION OF POSTSETTLEMENT DEPOSITION IN A NORTHWESTERN ILLINOIS SEDIMENT BASIN.
Illinois Univ., Urbana. Dept. of Agronomy.
W. R. Kreznor, K. R. Olson, D. L. Johnson, and R. L. Jones.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1393-1401, September/October 1990. 4 fig, 7 tab, 43 ref.

Descriptors: *Paleohydrology, *Soil erosion, *Sedimentation, *Illinois, *Deposition, *Watersheds, Soil horizons, Sediment transport, *Sediment distribution, Quantification, *Soil erosion, Storms, Rainfall.

This study quantifies the postsettlement deposition in a 24,900 sq m (2.49 ha) sediment basin with a single outlet in a 105,400 sq m (10.54 ha) watershed and estimate the sediment delivery to a first-order stream in northwestern Illinois. Methods included direct measurements of the eroded sediment deposited in the sediment basin. Buried A horizons (dated using fly ash as a time marker) identify the presettlement (approximately 1854) surface, which was overlain by as much as 116 cm of sediment. Volume of the sediment within the basin was calculated at 11,394 cubic m with a weight of 16,480 Mg. The modern soils of the sediment basin were characterized, classified, and the spatial variability of the sedimentation process was examined. Based on representative measurements of postsettlement sediment delivery obtained from research of drainage basins having similar size or soil characteristics, 20,975 Mg of sediment was delivered to the stream with a total of 37,455 Mg of soil being removed from the watershed hillslopes as a result of accelerated soil erosion. The measured rate of postsettlement sediment accumulation has been approximately 0.34 cm/year. Based on the tightly packed deposits, redeposition probably occurred as overland flow during storm events, rather than as overland flow occurring after a rainfall or as rainsplash transport. However, machinery traffic and cultivation could have contributed to the high soil bulk density. Intensive cultivation, biotic activity, and freeze-thaw are probably responsible for destroying any evidence of stratification. (Author's abstract)
W91-05185

PORTABLE LASER SCANNER FOR MEASURING SOIL SURFACE ROUGHNESS.
National Soil Erosion Lab., West Lafayette, IN.
C.-H. Huang, and J. M. Bradford.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1402-1406, September/October 1990. 4 fig, 8 ref.

Descriptors: *Soil surfaces, *Soil texture, *Measuring instruments, *Instrumentation, *Lasers, Tillage, Topography, Roughness coefficient, Boundary conditions, Computers.

Soil surface elevations are commonly measured along a profile at relatively large grid spacings between 5 and 50 mm. This limitation in measurement technique allows the description of surface roughness due to tillage marks and large clods only on the order of >= 20 mm. A portable scanner was designed to measure soil topography at variable grid spacings down to submillimeter scales. The scanner consisted of an optical transducer for measuring soil surface elevation, a motor-driven X-Y transversing frame, a set of processing and control electronics, and a personal computer. The optical transducer was mounted on the carriage of the X-Y transversing frame and programmed to scan a maximum area of 1 by 1 m. The personal computer controlled the scanning and recorded

elevation data. The system had no static noise and the combined frame vibration and spot size produced a positional and elevational resolution on the order of 0.1 to 0.3 mm. This scanner can be used to digitize surfaces at fine grid spacings and the detailed surface topography can then be used to study surface boundary processes such as soil erosion. (Author's abstract)
W91-05186

AGGREGATE STABILITY IN THE PALOUSE REGION OF WASHINGTON: EFFECT OF LANDSCAPE POSITION.
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.
F. B. Pierson, and D. J. Mulla.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1407-1412, September/October 1990. 3 fig, 3 tab, 28 ref.

Descriptors: *Soil stability, *Slope effects, *Geomorphology, *Soil erosion, *Soil physics, *Washington, *Soil aggregates, Soil types, Soil samples, Particle size, Soil water, Topography, Elevation, Soil properties.

An extensive study was conducted to measure spatial patterns when aggregate stability in the steep, hilly, and highly erodible loessial soils of the Palouse region in southeastern Washington. Soil samples were collected at 20-m spacings along four 800 m long transects within a winter wheat field and analyzed for aggregate stability at a slow and a fast rate of wetting, organic carbon, amorphous iron, soil water content, and particle size distribution. Aggregate stability under slow wetting, organic carbon, and clay content were significantly different at summit, shoulder, toeslope, and footslope positions, and lowest in footslope. Clay content was highest at the summit and lowest in footslope positions. Aggregate stability at a fast rate of wetting had a coefficient of variation (40%) that was nearly double that for slow wetting, and was not well correlated to either landscape position or measured soil properties. The variation in aggregate stability under slow wetting could be modeled in terms of organic carbon content and elevation. Other properties such as amorphous iron and water or clay content were only weakly correlated to aggregate stability. Thus, although the spatial patterns in aggregate stability exhibited moderate variability (CV = 22%), the patterns were closely related to changes in a few key properties, namely, organic carbon content and landscape position. A likely explanation for these findings is that soil erosion removes the topsoil and organic matter from the ridgetops, thus exposing subsoil horizons, which are higher in clay content and lower in aggregate stability. (Author's abstract)
W91-05187

FORMATION AND PHYSICAL STATE OF LEACHED FERRALLITIC SAVANNA SOILS OF MALI.
Moscow State Univ. (USSR). Dept. of Soil Science.
B. V. Timofeyev.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 8-17, 1989. 1 tab, 15 ref.

Descriptors: *Soil physical properties, *Soil conservation, *Soil genesis, *Leaching, *Mali, Soil compaction, Climatic changes, Climates, *Savannas, Deposition, Productivity, Degradation, Soil water, Humus, Nutrients.

Formation of leached ferrallitic concretionary soils of savannas of Mali occurs in densely inhabited areas which have been subjected to the effects of fire. They develop on an ancient thick eluvial weathering crust as the climate changes quickly from wet tropical to dry savanna and are pre-Quaternary in age. With an average rainfall in a typical savanna of 700 to 1250 mm and an evaporation ranging from 1700 to 2100 mm, precipitation is very unevenly distributed. Generally the soil cover is heterogeneous, and finds expression in the combination of dominant ferrallitic concretionary treeless microdepressions with a ferruginous laterite crust at a depth of 20 to 40 cm. The upper part of the weathering crust probably underwent local redeposition in the past. The productivity of the soils is very low and their practical use in farming is problematical due to disconnected contours. Maximum hygroscopic moisture in fine earth increases with depth from 4.5% to 6.0% in the upper horizons to 11.0% to 12.97% in the lower horizons. The prevention of degradation of savanna landscapes should reduce unproductive losses of moisture, increase the moisture-holding capacity of soils, improve microclimate, prevent erosion, increase the content of humus and nutrient elements in concretionary soils and preserve and restore soils and vegetation of unplowed savanna landscapes. (Brunone-PTT)
W91-05215

RED RIVER WATERWAY, REVISED OUTLETS FOR RED RIVER LOCKS: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. L. Stockstill.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-90-9, August 1990. Final Report. 79p, 14 fig, 21 photos, 19 plates.

Descriptors: *Red River, *Locks, *Hydraulic models, *Hydraulic profiles, *Model studies, Louisiana, *Sedimentation, Hydraulic design, Outlets, Hydraulic structures.

Sediment accumulation near the lower miter gates at Lock 1 on the Red River Waterway, Louisiana, caused difficulties in the operation of the lock. Sediment located this close to the structure could not be removed by typical means of dredging. A study using a 1:25-scale model was conducted to determine if the modification of the lock's emptying system would eliminate or reduce the amount of sediment depositing in the vicinity of the lower miter gates. The resulting modification that proved most feasible could be included in the emptying system design for Locks 4 and 5 on the Red River Waterway. To determine, qualitatively, the effectiveness of various outlet designs, crushed coal was placed in the vicinity of the lower miter gates, while the amount of coal displaced during emptying operations was used as a comparison. An outlet area design including baffles in front of the discharge manifold wall ports and a manifold designed specifically to flush sediment from the lower miter gates, resulted in the crushed coal being removed during a lock emptying operation; for the condition of maximum lift and for the condition of minimum lift when steady flow through the emptying system was maintained for 30 min (prototype). Designs incorporating more standardized sidewall manifolds combined with recessed pits in front of the manifold ports were developed that would also perform satisfactorily. (Author's abstract)
W91-05272

PREDICTION OF THE DESTRUCTION OF THE BANKS OF THE CHEBOKSARY RESERVOIR AS A RESULT OF A RISE OF THE LEVEL.
L. B. Ikonnikov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 61-63, 1990. 1 tab, 1 ref.

Descriptors: *USSR, *Landslides, *Dam effects, Hydraulic engineering, *Bank erosion, *Reservoir stages, *Hydroelectric plants, Reservoir operation, Erosion rates, Channel erosion, Backwater, Wave action, Energy equation, Sedimentation, Engineering geology, Water level fluctuations.

Filling of the Cheboksary reservoir in the U.S.S.R. began at the end of 1980. The presence of the backwater reduced or completely stopped the erosional action of the runoff current of the Volga River and its tributaries on the banks. The reservoir banks are forming in the lower parts of the slopes and within the floodplain of the Volga valley. Wave-effect erosion of the banks averages an insignificant 0.5-1.5 m/yr, because of the weak hydrodynamic effect of the reservoir, and on some slopes also by the strength of the rocks. Economic development of the reservoir bank zone requires a prediction of bank characteristics. The most substantiated method of predicting bank abrasion are the so-called energy methods. One of these methods was evaluated for use under conditions of the first years of reservoir operation at Cheboksary. The most important indices of the bank zone dynamics were analyzed and compared with actual data: retreat of the edge of the bank, volumes of bank erosion and accumulation of sediments near the bank, and width of the shoal near the bank. It was found that in all cases the calculated values of the indices of bank erosion were rather close to the actual ones: the differences were 4-19%. However, the method of calculating the volume of accumulation of sediments near the bank is in need of further development. The positive test results serve as grounds for using this method to predict the behavior of the banks in the case of filling the reservoir an additional 5 m. The rate of erosion of the banks will increase by 1.5-2 times in comparison with the rate noted during the first 8 years at the present water level. The threat of large slide movements will increase in the right-bank region both on stretches of their present development and on new stretches which are presently stable. (Fish-PTT)
W91-05301

RESULTS OF ON-SITE OBSERVATIONS OF LANDSLIDE SLOPES OF THE ZAGORSK PUMPED-STORAGE STATION AND RELIABILITY OF GEOLOGICAL FORECASTS.
For primary bibliographic entry see Field 8D.
W91-05306

LANDSLIDE AT THE ABUTMENT OF THE DAM OF THE MINGECHAUR HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8D.
W91-05307

CALCULATION OF THE CONTROLLING DEPTHS OF DEFORMABLE RIVER CHANNELS.
V. I. Antropovskii.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 136-141, 1990. 2 fig, 3 tab, 9 ref.

Descriptors: *Dam effects, *Sediment transport, *USSR, Hydraulic engineering, *Hydraulic models, *Channel morphology, *Water depth, Flow discharge, Flow channels, Canals, Canal design, Probability distribution, Hydroelectric plants, Navigation channels, River flow.

As a result of implementation of hydraulic structures and large water-management measures, water and sediment discharges change, and the effect of limiting factors (development of channel deformations) is manifested differently. It is necessary to evaluate channel characteristics under design conditions, including maximum depths for evaluating the reliability of underwater construction, and for determining navigation conditions and planning transportation works. The maximum depth of a certain probability for rivers in a natural state can be obtained from empirical probability curves plotted from depth sounding along the navigable channel or with the use of pilot charts. The problem of calculating the controlling depths under design conditions still remains unsolved owing to the difficulty of determining reliable methods of calculating the 'norm' (mean value) of the controlling depths within morphologically homogeneous river reaches. Relations can be improved using equiprobable values of the variables being related. During a test evaluation of various relations it was found that the closest relations were those of the equiprobable values of the ratio coefficients of the controlling depths to the channel width. Knowing the 'norm' of the depths, the controlling depths under design conditions are determined as a function of their distribution with the use of empirical or analytical probability curves. The bimodal distribution curve (Pearson type III curve), which usually corresponds to the observed data, is most widely used in engineering-hydrological calculations. As an example, a determination of the controlling depths of the Amur River, U.S.S.R., was made in the zone of

backwater pinchout from the planned hydro development with an elevation of the normal pool level of 85.0 m. The mean value of the maximum depth on the investigated reach under design conditions will be 8.13 m, where 6.50 m is the mean value under natural conditions. The results of the calculations by both the analytical probability curve and the mean empirical probability curve practically coincided. (Fish-PTT)
W91-05315

MARINE POLLUTION FROM LANDUSE IN THE PACIFIC ISLANDS REGION.
For primary bibliographic entry see Field 5B.
W91-05343

FACTORS CONTROLLING DEBRIS AVALANCHE INITIATION.
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
P. Buchanan, and K. W. Savigny.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 659-675, October 1990. 20 fig, 7 tab, 39 ref. Natural Sciences and Engineering Research Council of Canada Operating Grant A1923; University of British Columbia Equipment Grant 0071.

Descriptors: *Avalanches, *Debris avalanches, *Landslides, *Detritus, *Debris cones, *Slope stability, *Roots, Hydrologic models, Numerical analysis, Slopes, Soil water, *Slope protection, Storm water, Soil strength, Shear, Soil physical properties, Foundation failure, Pore pressure, Model studies.

Heavy rainfall during a January 1983 storm triggered numerous debris avalanches and associated debris torrents in the Smith Creek basin, western Whatcom County, Washington. Four classes of debris avalanches are recognized: wedges, drainage depressions, logging roads, and discontinuity surfaces. Nine different debris avalanche headscarps representative of these four classes were studied in detail. The geometric configuration of each headscarp, the properties of soils comprising the headscarps, and water tables based on numerical models of hillslope hydrology were used in limit equilibrium slope stability analyses to back-calculate root cohesion values at failure. Four groups of root cohesion values were correlated with forest vegetation: understory, 1.6 to 2.1 kPa; scrub forest, 2.1 to 2.5 kPa; mixed forest, 2.5 to 3.0 kPa; and old growth forest, >3.0 kPa. Soil matrix suction contributes significantly to slope stability under drained, initial conditions. Loss of soil matrix suction during rainstorms and loss of root cohesion at failure cause a sharp reduction of soil shear strength. The stability of each headscarp was modeled during a moderately severe comparison storm in December 1979. Failure was probable at only two of the nine sites, and field evidence of prior failure was found at one of these. Pore pressure increases triggered the debris avalanches; however, soil depth, soil density, the presence of smooth bedrock discontinuities, and root cohesion were shown to be important factors controlling initiation locations. Direct field measurement of the hydrologic shear and strength parameters is required before the modeling results and conclusions can be confirmed. (Author's abstract)
W91-05364

EROSION TESTS ON FOUR INTACT ONTARIO CLAYS.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
J. W. Kamphuis, P. N. Gaskin, and E. Hoogendoorn.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 692-696, October 1990. 2 fig, 3 tab, 8 ref.

Descriptors: *Erosion, *Soil erosion, *Soil tests, *Ontario, *Cohesive soils, Clays, Canada, Laboratory methods, Flumes, Shear stress, Soil properties, Sand, Suspended sediments, *Particle size.

The erosion of cohesionless soils is well understood but that of cohesive soils is not. Erosion testing of cohesive soils in the laboratory is now considered to be the best way of predicting field performance. Erosion tests were carried out on four natural intact cohesive soils from Ontario, Canada, using laboratory flume tests with both clear water and water with sand in suspension. It was found that erosion was initiated at discontinuities. The critical shear stresses were low and were not related to the geotechnical properties of the soils. Higher rates of erosion occurred with sand suspension, and erosion appeared to be controlled by the movement of sand particles. It is suggested that where the eroding water contains particles in suspension, such as in river beds and along shorelines of cohesive soil, erosion may be controlled by the size of the particles rather than the properties of the cohesive soil or the eroding water. (Author's abstract)
W91-05366

ANCIENT SUBAERIAL EXPOSURE AND FRESHWATER LEACHING IN SANDSTONES.
BP Exploration Co. Ltd., London (England).
D. Emery, K. J. Myers, and R. Young.
Geology GLGYBA, Vol. 18, No. 12, p 1178-1181, December 1990. 3 fig, 17 ref.

Descriptors: *Geologic history, *Geohydrology, *Leaching, *Meteoric water, *Sandstones, Geologic formations, Porosity, Permeability, North Sea, Potassium, Spectrometry, Geophysical methods, Seismic exploration, Oil reservoirs, Petrography, Brackish water, *Paleohydrology, *Weathering, *Aquifer characteristics, Formation water, *Interstitial water.

The potential of leaching by meteoric water as a means of bringing about a net porosity increase in ancient sandstones is of direct relevance to hydrocarbon exploration and production as a way of enhancing porosity and permeability in reservoir sandstones. An example of leaching by meteoric water in the Jurassic Magnus Sandstone Member of the northern North Sea was examined. Several independent techniques were used to gain information, such as downhole natural gamma-ray spectrometry, detailed petrographic analysis, and cross-sectional time-slice reconstructions from seismic data. The initial lines of evidence of leaching of meteoric water that prompted further investigation into freshwater involvement in the Magnus Sandstone Member were brackish formation-water compositions and a potassium depletion shown by the gamma-ray spectrometry log, in sandstone beneath the unconformity at the base of the Cretaceous section. Subsequent detailed petrographic study confirmed that the potassium depletion had been brought about by potassium feldspar dissolution, resulting in precipitation of kaolinite and creation of secondary porosity, the latter also revealed by conventional core-analysis porosity and permeability measurements. Finally, cross-sectional time-slice reconstructions from a regional seismic line across the Magnus oilfield strongly suggested subaerial exposure of the Magnus Sandstone Member in Early Cretaceous time and consequent freshwater leaching of the Magnus Sandstone Member and generation of the unconformity at the base of the Cretaceous. The combination of several lines of evidence from the Magnus field supports the process of subaerial exposure and freshwater leaching to create secondary porosity in sandstones. (Author's abstract)
W91-05368

FLOODS THREATENING KASHMIR WETLANDS.
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 2E.
W91-05385

NUTRIENT AND SEDIMENT LOSSES FROM TURFGRASS.
Maryland Univ., College Park. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-05396

TILLAGE EFFECTS ON SEDIMENT AND SOLUBLE NUTRIENT LOSSES FROM A MAURY SILT LOAM SOIL.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-05399

RESISTANCE IN FLAT-BED SEDIMENT-LADEN FLOWS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 2E.
W91-05425

BED FEATURES IN NONUNIFORM SEDIMENTS.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 2E.
W91-05426

HUANGHE (YELLOW RIVER) AND ITS ESTUARY: SEDIMENT ORIGIN, TRANSPORT AND DEPOSITION.
Ocean University of Qingdao, 5 Yushan Road, 266003 Qingdao, People's Republic of China.
J. Zhang, W. W. Huang, and M. C. Shi.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 203-223, December 1990. 7 fig, 2 tab, 26 ref.

Descriptors: *China, *Estuaries, *Huang He River, *Sediment load, *Sediment transport, *Sedimentation, Aggrading rivers, Deltas, Flow discharge, River flow, Sediment discharge, Sediment erosion.

The upper part of the Huanghe (Yellow River) drainage basin supplies 50-60% of the annual water discharge and only 10% of the total river sediment load, while the middle reaches contribute 30-40% of the water flow and 90% of the annual sediment load, because of severe erosion over the loess plateau. Large variations in both annual water discharge and sediment load occur in the Huanghe. Heavy sedimentation in the lower reaches of the channel makes the river bed aggrade several centimeters/yr. Of the suspended sediment in the river, 90-95% is deposited in the lower part of the river course and in the coastal shallow water area; less than 5-10% escapes from Laizhou Bay and enters the Central Bohai and/or North Huanghai (Yellow Sea). The active delta complex now propagates seaward at a mean rate of 42 sq km/yr. (Author's abstract)
W91-05439

PARTICLE FLUXES AND ECOSYSTEM RESPONSE ON A CONTINENTAL MARGIN: THE 1985-1988 MEDITERRANEAN ECOMARGE EXPERIMENT.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
A. Monaco, P. Biscaye, J. Soyer, R. Pocklington, and S. Heussner.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 809-839, 1990. 8 fig, 93 ref. DOE Grant No. DE-FGO2-87ER60555.

Descriptors: *Continental margin, *Gulf of Lions, *Mediterranean Sea, *Particulate matter, *Sediment transport, Coastal waters, Cycling nutrients, Discharge rates, Marine environment, Organic carbon, Particle transport, Seasonal distribution, Sedimentation, Submarine canyons, Temporal variation, Turbidity.

The first experiment of the ECOMARGE program was initiated in 1983 to 1984, in the Gulf of Lions (northwestern Mediterranean Sea) to quantify the transfer of particulate matter, in general, and or organic carbon, in particular, from introduction to and formation in the waters of the continental shelf to consumption or sedimentation on the shelf or the transfer to the slope and deep sea; and to understand the processes involved in the transfer, consumption, and sedimentation together with spatial and temporal variability. The results indicate that some particles formed in the waters of the

continental shelf or introduced by rivers are deposited as sediments on the shelf; some are transported to the slope and deep sea. In the offshore waters, particle concentrations and distributions show surficial, intermediate and benthic nepheloid layers. These turbid structures increase correspondingly with the seaward shift of the front between the coastal waters and the Liguro-Provencal cyclonic gyre, a major forcing function in the Gulf of Lions. The temporal variability of processes affecting the seaward transport, of both biogenic and abiogenic material, is from hours, days to seasonal, and probably interannual time scales. The response of the system to the variations is rapid, with pulses of increased discharge of particles from the continental shelf recorded in sea canyons in less than 16 days. Based on study of tracers of particulate matter and environmental factors, the contribution from the Rhone River and adjacent areas is maximal during the winter; while the maximum relative contribution of the adjacent southwesterly area to the flux in the Lacaze-Duthiers Canyon occurs in summer, during storm events. (Author's abstract)
W91-05450

MASS-PHYSICAL PROPERTIES OF SURFICIAL SEDIMENTS ON THE RHONE CONTINENTAL MARGIN: IMPLICATIONS FOR THE NEPHELOID BENTHIC LAYER.
Nice Univ. (France).
B. Chassefiere.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 857-867, 1990. 6 fig, 1 tab, 25 ref.

Descriptors: *Continental margin, *Gulf of Lions, *Mediterranean Sea, *Sediment discharge, *Sediments, Coastal waters, Lagoons, Physical properties, Rhone River, Rivers, Shear strength, Stream discharge, Suspended particulate matter.

Mass physical properties of the surficial (upper 5 m) sediments on the Gulf of Lions continental shelf were analyzed from more than 100 short (1 m) and longer (5 m) cores obtained during several cruises. Data include water content, unit weight, Atterberg limits (liquid limit, plastic limit, plasticity index), shear strength, and compression index, and are used to determine the mass property distribution, according to the main parameters influencing mass physical properties; and the relationships between these properties and the nepheloid layer on the shelf. The shoreline (lagoons) and inner shelf are characterized by low density and shear strength and high water content deposits, due to electrochemical flocculation of the sediment. The outer shelf is blanketed by higher density and shear strength and lower water content deposits generated by normal settling of suspended particles. On the inner shelf, during river peak discharges, a short term thin bottom layer of fluid-mud (unit weight lower than 1.3 mg/cu m) is supplied by a bottom nepheloid layer. During stormy periods, this layer (about 10 cm thick) partly disappears by resuspension of suspended particulate matter advected, in the bottom nepheloid layer, over the shelf and canyons within the upper slope. (Author's abstract)
W91-05451

CAESIUM DISTRIBUTION IN NORTHWEST MEDITERRANEAN SEAWATER, SUSPENDED PARTICLES AND SEDIMENTS.
Commissariat a l'Energie Atomique, La Seyne-sur-mer (France).
For primary bibliographic entry see Field 5B.
W91-05453

HYDROGRAPHIC STRUCTURE AND NEPHELOID SPATIAL DISTRIBUTION IN THE GULF OF LIONS CONTINENTAL MARGIN.
Neuchatel Univ. (Switzerland). Groupe Oceane.
X. D. de Madron, F. Nyffeler, and C. H. Godet.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 915-929, 1990. 7 fig, 1 tab, 30 ref.

Descriptors: *Continental margin, *Gulf of Lions, *Hydrography, *Mediterranean Sea, *Sediment transport, *Spatial distribution, *Suspended sediments, Coastal waters, Nephelometry, Particulate matter, Rhone River, Seasonal distribution, Suspended solids, Water circulation.

A general hydrographic and nephelometric survey of the Gulf of Lions margin was undertaken under autumn conditions. The distribution of suspended material along the margin during this experiment is controlled, at least in part, by the following factors: the hydrography of the shelf-slope waters (i.e. the nepheloid layers follow the isopyenals), and the cyclonic circulation of the water masses (the Liguro-Provencal Current and, in particular the proximity and depth of the Levantine Intermediate Water circulation). On the northeastern part of the margin along the slope, the seaward extension of the nepheloid layers is sharply bounded and is concentrated in canyon heads by the general water circulation. In the southwestern part, the decreasing depth of the major flow of the general circulation and its increased distance seaward from the upper slope allow the seaward and downward expansion of the nepheloid structures. The suspended material extending offshore is swept away and diluted by the general circulation. The stepwise increase toward the southwest, in suspended particulate contents in the slope waters between the northeastern and southwestern ends of the Gulf of Lions margin, is influenced less by the Rhone and other rivers of the shelf. The influence of the Rhone is seen first at the longitude of the Rhone canyon. In the southwestern part of the Gulf, the Bourcart and Lacaze-Duthiers canyons are areas through which the suspended material, originating from the wholeshelf, passes. (Author's abstract)
W91-05454

210-PO, 210-PB IN SEDIMENT TRAP PARTICLES ON A MEDITERRANEAN CONTINENTAL MARGIN.
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
S. Heussner, R. D. Cherry, and M. Heyraud.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 989-1004, 1990. 3 fig, 4 tab, 49 ref.

Descriptors: *Continental margin, *Gulf of Lions, *Lead radioisotopes, *Mediterranean Sea, *Polonium radioisotopes, *Sediment transport, *Tracers, Carbonates, Coastal waters, Fluctuations, Organic matter, Particulate matter, Rhone River, Seasonal variation, Sediment sampler, Silica, Stream discharge.

Concentrations of the natural radionuclides polonium-210 and lead-210 were measured in particulate matter collected in sediment traps, deployed in the Gulf of Lions in the northwestern Mediterranean Sea during the first phase of the ECOMARGE program (between July 1985 and April 1986). The data obtained are unexceptional in terms of the absolute concentrations measured, but show interesting features in the polonium-210/lead-210 activity ratios. These are high (about 6) in samples collected in summer at 50 m depth, they are above unity in all except one of the 50 and 100 m depth samples, and are less than unity in most of the deeper (300 and 600 m) samples. There is a clear tendency for lead-210 to covary with organic matter and biogenic silica; likewise, for polonium-210 to covary with carbonates and refractory silicates. Particulate matter fluxes and nuclide fluxes into the deep traps were very high in winter. The utility of the polonium-210/lead-210 activity ratios, as indicators of the origin of these fluxes, is highlighted. These results suggest that deep traps in the Gulf of Lions continental margin were, in winter, fed mainly by a lateral transport of riverine particles; these, in turn, originated largely in the Rhone River. (Author's abstract)
W91-05456

FLUX OF TRANSURANIUM NUCLIDES AND CHLORINATED HYDROCARBONS IN THE NORTHWESTERN MEDITERRANEAN.
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5B.
W91-05457

CONTRIBUTION OF THE RHONE RIVER TO ORGANIC CARBON INPUTS TO THE NORTHWESTERN MEDITERRANEAN SEA.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
G. Cauwet, F. Gadel, M. M. de Souza Sierra, O. Donard, and M. Ewald.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 1025-1037, 1990. 6 fig, 1 tab, 21 ref.

Descriptors: *Gulf of Lions, *Mediterranean Sea, *Organic carbon, *Path of pollutants, *Rhone River, *Sediment transport, *Stream discharge, Coastal waters, Continental margin, Diagenesis, Particle transport, Particulate matter, Suspended sediments, Water column.

Particulate and dissolved organic carbon were determined in coastal waters of the Gulf of Lions in the northwestern Mediterranean Sea, during several cruises from 1986. The input of particulate matter from the Rhone River settles rapidly in the coastal zone. Dissolved organic matter is partly involved in this fast sedimentation process, but most of it is widely dispersed during the mixing process, giving rise to concentration gradients. Due to coastal and river dynamics, or to resuspension processes, a small fraction of the sediment remains in suspension, feeding the bottom nepheloid layer which is then spread on the continental margin. Periodic resuspension of sediment and permanent diffusion releases the mobile organic matter fraction into the water column, enriching bottom waters. Fluorescence measurements show the limited influence on the open sea of surface particulate matter, but suggest a bottom transport during which diagenic evolution can occur. Studies are in progress on the relation between the nepheloid layer and the sediment and on the consequences of resuspension in terms of mobilization of chemical compounds. (Brunone-PTT)
W91-05458

TRACERS AND CONSTITUENTS INDICATING THE NATURE OF ORGANIC FLUXES, THEIR ORIGIN AND THE EFFECT OF ENVIRONMENTAL CONDITIONS.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
For primary bibliographic entry see Field 2L.
W91-05459

ANALYSIS OF DEWATERING CHARACTERISTICS OF LAKE AND RIVER SEDIMENTS.
National Chemical Lab. for Industry, Yatabe (Japan).
For primary bibliographic entry see Field 5G.
W91-05525

CHARACTERISTICS OF A MARSHLAND SOIL BUILT UP FROM MARINE AND PEAT MATERIAL.
Oldenburg Univ. (Germany, F.R.). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-05568

FATE OF MANGROVE LITTER IN A MANGROVE FOREST ON KO YAO YAI, SOUTHERN THAILAND.
Phuket Marine Biological Center (Thailand).
For primary bibliographic entry see Field 2L.
W91-05574

DIFFUSIVE BOUNDARY LAYER OF SEDIMENTS: OXYGEN MICROGRADIENTS OVER A MICROBIAL MAT.
National Aeronautics and Space Administration, Moffett Field, CA. Ames Research Center.
For primary bibliographic entry see Field 2H.
W91-05584

MULTILEVEL, IN SITU PORE-WATER SAMPLER FOR USE IN INTERTIDAL SEDIMENTS AND LABORATORY MICROCOSMS.
Plymouth Marine Lab. (England).
For primary bibliographic entry see Field 7B.
W91-05586

SUBSIDENCE, ACCRETION, AND SEA LEVEL RISE IN SOUTH SAN FRANCISCO BAY MARSHES.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
For primary bibliographic entry see Field 2L.
W91-05587

NITROGENOUS NUTRIENT TRANSFERS IN OYSTER PONDS: ROLE OF SEDIMENT IN DEFERRED PRIMARY PRODUCTION.
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
For primary bibliographic entry see Field 2H.
W91-05589

SOIL, LANDSCAPE, AND EROSION RELATIONSHIPS IN A NORTHWEST ILLINOIS WATERSHED.
Illinois Univ., Urbana. Dept. of Agronomy.
W. R. Kreznor, K. R. Olson, W. L. Banwart, and D. L. Johnson.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1763-1771, November/December 1989. 3 fig, 6 tab, 54 ref.

Descriptors: *Erosion, *Geomorphology, *Illinois, *Landscapes, *Mapping, *Topography, Catchment areas, Cultivated lands, Organic carbon, Overland flow, Slopes, Soil types, Topographic mapping.

The relationship was established between soil taxonomic description, landscape form and position, and erosion in northwest Illinois. The study area consists of a first-order drainage basin about 10 ha in size. The hillslopes have mean gradients of 6 to 10% with overland flow the primary contributor to erosion. A detailed geomorphic map of the watershed was constructed on a 1 m topographic survey base map. Map units were delineated based on slope shape, gradient, and USDA erosion class. Erosion classes were determined for the transect pedons by comparison with two uneroded and uncultivated pedons in area cemeteries with similar slope gradient, slope shape, slope length, and landscape positions. The A horizon thickness and organic carbon content decreased and clay content increased as a consequence of cultivation and erosion. Transect data for all hillslope geomorphic units showed the erosion classes near the shoulder to be either slightly or moderately eroded. The lower backslopes and upper footslopes, just above the sediment basin, were either severely or very severely eroded, suggesting slope length to be the dominant factor affecting erosion. The geomorphic units with concave across-slope shapes were found to be less eroded than those with convex across-slope shapes. All cultivated pedons failed to meet the criteria for Mollisols, which was the taxonomic placement of the uncultivated pedons. Erosion phase, landscape segment, slope shape, slope gradient, and slope length affected the taxonomic placement of the cultivated hillslope soils when compared with uncultivated sites. (Author's abstract)
W91-05606

USING COMMON SENSE TO PREVENT SOIL EROSION FROM URBAN DEVELOPMENT AREAS.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
For primary bibliographic entry see Field 4D.
W91-05619

EFFECTS OF HURRICANE STORM FLOW ON TRANSPORT OF WOODY DEBRIS IN A RAIN FOREST STREAM (LUQUILLO EXPERIMENTAL FOREST, PUERTO RICO).
Oklahoma Univ., Norman. Dept. of Zoology.
A. P. Covich, and T. A. Crowl.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 197-205, 3 fig, 1 tab, 21 ref. NSF Grant No. BSR-8811764.

Descriptors: *Flow control, *Forest watersheds, *Hurricanes, *Luquillo Experimental Forest, *Puerto Rico, *Rain forests, *Storm runoff, *Tropical hydrology, *Woody debris, Detritus, Mountain streams, Quebrada Prieta, Rainfall-runoff relationships, Streamflow, Surface runoff.

The downstream movement of marked woody debris was determined (120 individually numbered hardwood dowels) along a 300 meter reach of the Quebrada Prieta, a second order boulder lined, montane stream in northeastern Puerto Rico. The study began in 1988 to establish a baseline for measuring effects of storm flow on the transport and retention of woody debris during hurricane events. The study continued through January 1990, and evaluated the effects of Hurricane Hugo on movement of woody debris. Cohorts of 20 dowels were placed into an upstream pool approximately every two months to avoid a large accumulation of dowels at the release point. The dowels dispersed downstream in a negative exponential pattern. Retention time within the stream channel and percentage recovery of the marked dowels were higher before and after the hurricane than after expected. Prior to the hurricane, 83% to 100% of the dowels were recovered and 60% could still be located after the storm flow. The authors hypothesize that retention time is long because of the large number of crevices in this rocky stream and the entrapping effects of exposed tree roots in undercut banks. Also, streamflow associated with Hurricane Hugo was low relative to other tropical storm events. (See also W91-05611) (Author's abstract)
W91-05631

SILTATION OF RESERVOIRS IN AGRICULTURAL WATERSHEDS DETERMINED USING RADIOISOTOPE TECHNIQUES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
J. W. Naney, and S. C. McIntyre.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 465-474, 6 fig, 1 tab, 20 ref.

Descriptors: *Agricultural watersheds, *Land use, *Radioisotopes, *Reelfoot Lake, *Reservoir silting, *Sedimentation, *Silting, *Tracers, *Tropical hydrology, Case studies, Cesium radioisotopes, Lake sediments, Lead radioisotopes, Oklahoma, Radioactive tracers, Reservoirs, Tecumsah Lake, Tennessee, Tracer studies.

Results of studies of two lakes in very different watershed environments show that the use of the radioisotopes 137-Cs and 210-Pb to determine siltation rates is feasible. Dating of sediments relative to known decay rates of the isotopes attached to fine soil particles establishes useful criteria for assessing changes in sediment deposition caused, in part, by major shifts in agricultural land management. The 137-Cs concentration of lake bottom sediment cores from Tecumsah Lake, Oklahoma, indicates a distinct reduction in the rate of sediment deposition associated with a major shift in land use from cotton to grass pasture in 1954. This finding implies that sedimentation rates could be accelerated by land clearing for urban development in the future. Important impacts on the lake are evident in less than 50-100 years typically used as planning criteria for water supply lakes. In Reelfoot Lake, Tennessee, 137-Cs and 210-Pb made it possible to estimate siltation rates not easily determined otherwise. Periods of increased siltation in Reelfoot Lake closely correspond to major changes in agricultural practices within the Reelfoot Lake watershed. Results indicate that Buck Basin will fill with sediment in 200 years if siltation continues at the current rate. (See also W91-05611) (Lantz-PTT)
W91-05658

NUMERICAL SIMULATION OF SHORELINE CHANGE AT LORAIN, OHIO.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
H. Hanson, and N. C. Kraus.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 1, p 1-18, 1991. 11 fig, 32 ref.

Descriptors: *Beach erosion, *Breakwaters, *Lake shores, *Model studies, *Numerical analysis, *Ohio, *Shore protection, Beaches, Lake Erie, Wave direction, Wave height, Waves.

Design of detached breakwaters for shore protection is difficult because the response of the shoreline is governed by at least 14 geometric, wave, and sediment-related variables. Numerical models of shoreline change have the potential for incorporating these variables to predict the time evolution of the beach plan shape; however, wave transmission at breakwaters has been a major process absent from such models. A pragmatic method has been developed for calculating the breaking-wave height and angle under combined transmission, diffraction, refraction, and shoaling. This model was tested to predict shoreline change measured at Lorain, Ohio, the site of a three-segment transmissive breakwater system. The model successfully simulated observed shoreline change at the site that occurred over three time periods ranging from one to five years. Sensitivity tests and evaluation of potential alternative shore-protection designs were made to demonstrate the economy and utility of the numerical model. The project design, consisting of detached breakwaters and two groins surrounding a beach fill, functioned in a manner superior to the alternatives of fill plus breakwaters only and fill plus groins only. The present results provide only indirect verification of the wave algorithm; the individual calculation modules for wave transformation, longshore sand transport, and beach change should be individually tested and refined, if necessary. (Fish-PTT)
W91-05782

GEOCHEMICAL FLOWS OF MICROELEMENTS IN AGRICULTURAL LANDSCAPES OF THE CENTRAL EUROPEAN USSR.
Institut Fotosinteza, Pushkino SSR).
V. A. Kovda, and V. P. Uchvatov.
Soviet Soil Science SSSCAE, Vol. 21, No. 2, p 86-89, 1989. 3 tab, 9 fig. Translated from: Doklady Akademii Nauk SSSR, Vol. 302, No. 1, p 211-214, 1988.

Descriptors: *Cropland, *Erosion, *Nutrient removal, *Soviet Union, Agricultural runoff, Fertilizers, Forest soils, Geochemistry, Hydrologic budget, Micronutrients, Nutrients, Soil genesis.

One of the factors limiting soil fertility and crop yields is erosion of the soil cover. The extent of human-caused erosion in some parts of the world is 1-1.5 orders of magnitude greater than the rate of natural mechanical denudation. In 1977-1983 an integrated study was conducted of the geochemical flows and the balance of matter in certain agricultural production landscapes typical of the central zone of the European Soviet Union. Microelement compositions were determined in cultivated and uncultivated soils. Soils under forest in their natural state had 1.1-2.3 times as much of almost all of the microelements studied (except Mo, Ag, and Zr) and of humus as cultivated soils and slope soils where hay is grown. The concentration of microelements in cultivated and slope soils approached the concentrations in the parent material. 'Technological erosion,' which is the removal of soils from the site along with root crops being delivered to localities hundreds of miles away, causes substantial soil losses during the harvest season. Soil denudation in the southern Moscow region in the years with the most favorable weather conditions may be as much as 0.4 mm/yr, nearly an order of magnitude greater than the rate of natural soil formation, if it is assumed that the formation of the humus horizon of Gray Forest soils 30-40 cm thick requires 8-10 thousand years (the duration of the Holocene). The loss of microelements from the agricultural landscape from technological erosion considerably exceeds losses occurring by all other means; in years of unfavorable weather conditions this can be as

much as 50-70% of the total losses of microelements from the agricultural landscape. The losses of microelements are partially compensated by precipitation and added mineral fertilizers. An important agricultural consequence of the loss of microelements and humus from the agricultural landscape is the decrease in the amounts of mobile forms of nutrients bound to soil organic matter that are needed by crops. (Rochester-PTT)
W91-05828

HYDRAULIC RESPONSE OF HIGHLY COMPRESSIBLE AQUITARDS DURING CONSOLIDATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2F.
W91-05833

GROWTH OF ALTERNATE BARS IN UNSTEADY FLOW.
Genoa Univ. (Italy). Inst. of Hydraulics.
M. Tubino.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 37-52, January 1991. 16 fig, 3 tab, 27 ref.

Descriptors: *Channel morphology, *Channel stability, *River beds, *Streambeds, *Unsteady flow, Artificial watercourses, Flood discharge, Hydraulic models, Hydraulics, Laboratory methods, Mathematical analysis.

Many data have been collected on the occurrence of bars, both in the field and in the laboratory, and on the geometric and hydraulic characteristics of alternate bars under steady-flow conditions. A rational (theoretical) interpretation of the physical process has been developed through a large number of linear studies. A theoretical model has been formulated to investigate the development of the amplitude of alternate bars in unsteady flow. The problem was solved using a weakly nonlinear analysis developed in a neighborhood of the threshold conditions of bar formation. Bar response to unsteady flow depends on a parameter (U) that is a measure of the ratio between the time scale of the basic flow and the time scale of bar growth (an unsteadiness parameter). The theory shows that if U is O(1), as often occurs in nature, flow unsteadiness affects the instantaneous growth rate and phase of bar perturbation and controls the final amplitude reached by the bed configuration. A procedure for determining the final amplitude for a given flood event has been devised. Flume experiments were performed to test the main theoretical results. The bed response to unsteady flow was measured for different values of the period of the flood. The observed temporal behavior of the bar amplitude proves to be strongly affected by the unsteady character of the flow of U of O(1), as predicted by the theory. (Author's abstract)
W91-05835

PIPING AND EROSION TESTS AT CONNER RUN DAM.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 8D.
W91-05870

NUTRIENT TRAPPING EFFICIENCY OF A SMALL SEDIMENT DETENTION RESERVOIR.
Agricultural Research Service, Oxford, MS. Sedimentation Lab.
C. M. Cooper, and S. S. Knight.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 149-158, July 1990. 2 fig, 2 tab, 11 ref.

Descriptors: *Detention reservoirs, *Mississippi, *Nutrient trapping, *Nutrients, *Suspended sediments, Chlorophyll a, Nitrates, Nitrogen compounds, Phosphorus, Phytoplankton, Rainfall-runoff relationships, Reservoir silting, Seasonal variation, Small watersheds.

Weekly measurements of water quality parameters were taken over a 5 year period from four sites in Morris Pond, a 1.09 ha reservoir in the loess hills of Mississippi's Goodwin Creek drainage basin. Catchment of the 30 year old reservoir, constructed for flood and sediment control, consisted of 17.8 ha of permanent pasture and 14.6 ha of cultivated and mixed-cover land Inflow in winter and spring increased reservoir concentrations of phosphorus (from nondetectable to 1 mg/L), nitrate-nitrogen (from nondetectable to 1 mg/L) and suspended sediments (from 30 to >300 mg/L). Storm-related inflow was the driving force behind short-term limnological and water quality cycles in Morris Pond. Multiple chlorophyll peaks indicated rapid phytoplankton response to runoff-related nutrient loading in this shallow (2.5 m normal max. depth) reservoir. Chlorophyll a ranged from <10 mg/cu m in winter to <100 mg/cu m in summmer. Nutrient and suspended sediment concentration in inflow were significantly correlated ($P<0.001$) with precipitation and storm runoff and were significantly ($P<0.05$) higher than normal seasonal pond concentrations. Nutrient trapping efficiency during storms averaged above 70% for phosphorus and nitrogen compounds flushed into the pond. The buffering capability of agricultural impoundments makes them excellent tools for managing intensive agricultural runoff and downstream water quality. (Author's abstract)
W91-05926

ASSESSMENT OF FUTURE COAST LAND LOSS ALONG THE UPPER TEXAS GULF COAST TO THE YEAR 2050.
Texas Univ. at Austin. Dept. of Geological Sciences.
S. J. Germait, and J. M. Sharp.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 27, No. 3, p 263-280, 1990. 7 fig, 6 tab, 61 ref.

Descriptors: *Beach erosion, *Coastal areas, *Coastal zone management, *Gulf of Mexico, *Sea level, *Shoreline retreat, *Subsidence, Land development, Model studies, Projections, Upper Texas Gulf Coast.

Three scenarios (baseline, low-rise and high-rise) for shoreline retreat and resulting loss of land to the year 2050 are developed for the Upper Gulf Coast, north of the Galveston Bay. The scenarios integrate projections of future relative sea-level (RSL) rise with empirical relations between RSL rise and shoreline retreat over an historical baseline period. The projections of future RSL rise with empirical relations between RSL rise and shoreline retreat over an historical baseline period. The projections of future RSL rise combine estimates of eustatic sea-level rise derived from a delphic analysis with an assumed constant rate of land-surface subsidence. RSL rises of 0.49 m, 0.63 m and 1087 m are computed for the year 2050 in the baseline, low-rise and high-rise scenarios, respectively. These rises correspond to losses of land of 17.1 sq km (4224 acres), 22.4 sq km (5533 acres) and 68.5 sq km (16,920 acres) within the study area. Although the loss of land varies considerably throughout the study area, shoreline retreats of up to 1.85 km by 2050 are predicted in the worst-case (high-rise) scenario. (Author's abstract)
W91-05936

ECONOMICS OF SOIL EROSION AND CONSERVATION ON SIX SOIL GROUPINGS IN MANITOBA.
Agriculture Canada, Brandon (Manitoba). Research Station.
E. G. Smith, and C. F. Shaykewich.
Canadian Journal of Agricultural Economics, Vol. 38, No. 2, p 215-231, July 1990. 1 fig, 4 tab, 34 ref.

Descriptors: *Canada, *Crop production, *Model studies, *Soil conservation, *Soil erosion, *Tillage, Conservation tillage, Cost analysis, Crop rotation, Economic evaluation, Linear models, Linear programming, Manitoba.

The effect of soil erosion on optimal cropping and tillage practices are determined using a dynamic linear programming model. The analysis recognizes the effect that current soil erosion has on future production. The productivity declines in the model from soil erosion are estimated from a study that artificially eroded soil at six sites. The optimal cropping practice indicates that minimum tillage is the best way to reduce soil erosion, Nonerosive crops such as hay or zero tillage practices are not as profitable as minimum tillage with cereal grain-oilseed crop rotations. The value of soil conserved by the least erosive practices (zero tillage and/or hay production) is less than the additional costs or lower returns of the practice. The marginal user cost ranges from $0.00 to $0.55 per hectare per year, depending on the soil grouping. The marginal user cost of soil is affected by the productivity impact of erosion, prices of commodities, fertilizer prices, technology and the discount rate. The $0.00 values are from a soil grouping that had limited data from two contrasting years. (Author's abstract)
W91-05938

2K. Chemical Processes

CHLORINATION OF HUMIC MATERIALS: BYPRODUCT FORMATION AND CHEMICAL INTERPRETATIONS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-04946

IMPACT OF EUTROPHICATION ON THE SILICATE CYCLE OF MAN-MADE BASINS IN THE RHINE DELTA.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04959

CONCENTRATION AND PARTIONING OF PARTICULATE TRACE METALS IN THE CHANGJIANG (YANGTZE RIVER).
Department of Marine Chemistry, Ocean Univ. of Qingdao, 5 Yushan Road, Qingdao 266003, P.R. China.
For primary bibliographic entry see Field 5B.
W91-04969

CONTROLS ON SURFACE WATER CHEMISTRY IN THE SOUTHERN BLUE RIDGE AND PIEDMONT PROVINCES.
For primary bibliographic entry see Field 5B.
W91-04971

INFLUENCES OF TEMPERATURE ON AQUEOUS ALUMINUM CHEMISTRY.
Norges Landbrukshoegskole, Aas. Isotope Lab.
E. Lydersen, B. Salbu, A. B. S. Poleo, and I. P. Muniz.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 203-215, 1990. 3 fig, 2 tab, 27 ref.

Descriptors: *Acid rain, *Aluminum, *Chemical interactions, *Environmental chemistry, *Path of pollutants, *Temperature effects, *Water chemistry, Chemical analysis, Chemical precipitation, Chemical properties, Hydrogen ion concentration.

Temperature affects the solubility of Al(OH)3(s), the solubility product formed, the hydrolysis and molecular weight distribution of aqueous Al species as well as the pH of the solutions. Identical solutions of inorganic Al (400, 600, and 800 microg Al/L) were stored for 1 month at either 2 or 25 C. In the solutions stored at 2 C, pH varied from 5.64 to 5.78. In spite of the relatively low pH at 25 C, significant amounts of high molecular weight Al species were precipitated from the solution and the solubility product of Al(OH)3(s) was low (9.0). Substantial amounts of high molecular weight Al species were also formed at 2 C, but the majority was present as colloids in the solution. The solubility product (converted from 2 to 25 C) was 10.2, reflecting a solubility product of an amorphous Al(OH)3(s) phase. The different physicochemical forms of Al present at 2 and 25 C should have relevance for water/soil chemistry modeling. (Author's abstract)
W91-04977

SIMULATION OF HYDROCHEMISTRY IN A HIGHLAND SCOTTISH CATCHMENT USING THE BIRKENES MODEL.
Oslo Univ. (Norway). Dept. of Chemistry.
A. Stone, H. M. Seip, S. Tuck, A. Jenkins, and R. C. Ferrier.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 239-259, 1990. 9 fig, 2 tab, 25 ref.

Descriptors: *Acid rain effects, *Birkenes Model, *Hydrologic models, *Model studies, *Scotland, *Simulation analysis, *Water chemistry, *Watersheds, Anions, Cations, Chemical analysis, Water quality.

An important indicator of the quality of hydrochemical simulation models is their ability to be used in a wide range of catchment types. The Birkenes Model, built primarily upon data from a small basin in southern Norway, was used to simulate a highland Scottish catchment with physical and chemical characteristics quite different from those at Birkenes. The hydrological and chemical signals were simulated and compared to observations and results from earlier Birkenes simulations. The results indicate that the basic chemical processes are qualitatively represented in the model, and that it is possible to simulate hydrochemical observations for varying catchment types. The broad trends in stream concentrations for all the major anions and cations are reproduced. Although short-term variations are not simulated equally well, the results strengthen confidence in the predictions of the Birkenes Model even though the model is a highly simplified description of a complicated system. (Author's abstract)
W91-04978

OCCURRENCE AND DISTRIBUTION OF METHANE THIOL AND OTHER VOLATILE SULPHUR COMPOUNDS IN A STRATIFIED LAKE WITH ANOXIC HYPOLIMNION.
Institut Fresenius Chemische und Biologische Laboratorien G.m.b.H., Taunusstein-Neuhof (Germany, F.R.).
J. J. Henatsch, and F. Juttner.
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 3, p 315-323, September 1990. 3 fig, 29 ref.

Descriptors: *Anoxic conditions, *Lake stratification, *Limnology, *Methane thiol, *Sampling, *Sulfur compounds, Carbon disulfide, Chemical analysis, Dimethyl sulfide, Germany, Hypolimnion, Odors, Organic compounds, Schleinsee Lake, Water chemistry.

Methane thiol and other volatile thiol compounds have been determined in a stratified lake (Schleinsee, SW Germany) with anoxic hypolimnion. Methane thiol was the major volatile sulfur compound in the anoxic water layers and exhibited increasing concentrations from the metalimnion to the sediment. The maximum concentration observed was 3 micro grams/L. Dimethyl sulphide was only found in water layers near the sediment. Carbon disulfide exhibited rather low concentrations around 20 ng/L with little variation in the hypolimnion. S-methyl thiopropionate, which has not been described before in natural waters, was restricted to the anoxic layer. In the oxygen containing epilimnion, dimethyl disulfide was the only volatile sulfur compound observed. Vertical profiles taken from July through December showed the continued presence of high concentrations of methane thiol in the anoxic hypolimnion. (Author's abstract)
W91-04999

MECHANISMS CONTROLLING CU, FE, MN, AND CO PROFILES IN PEAT OF THE FILSON CREEK FEN, NORTHEASTERN MINNESOTA.
Geological Survey, Denver, CO.
K. Walton-Day, L. H. Filipek, and C. S. E. Papp.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 11, p 2933-2946, November 1990. 11 fig, 2 tab, 65 ref.

Descriptors: *Fens, *Geochemistry, *Groundwater chemistry, *Metals, *Mineral exploration, *Peat, *Wetlands, Cobalt, Copper, Filson Creek Fen, Interstitial water, Iron, Manganese, Metal distribution, Minnesota, Soil water, Vertical distribution, Water chemistry.

Filson Creek Fen, located in northeastern Minnesota, overlies a Cu-Ni sulfide deposit. A site in the fen was used to evaluate the hydrogeochemical mechanisms governing the development of Fe, Mn, Co, and Cu profiles in the peat. At the study site, surface peat approximately 1 m thick is separated from the underlying mineralized bedrock by a 6-12 m thickness of lake and glaciofluvial sediments and till. Concentrations of Fe, Mn, Co, and Cu in peat and major elements in pore water delineate a shallow, relatively oxidized, Cu-rich zone overlying a deeper, reduced, Fe-, Mn-, and Co-rich zone within the peat. Sequential metal extractions from peat samples revealed that 40-55% of the Cu in the shallow zone is associated with organic material, whereas the remaining Cu is distributed between iron-oxide, sulfide, and residual fractions. Sixty to seventy percent of the Fe, Mn, and Co concentrated in the deeper zone occurs in the residual phase. The metal profiles and associations probably result from non-steady-state input of metals and detritus into the fen during formation of the peat column. The variable stratigraphy of the fen indicates that weathering processes and surface vegetation have changed through time in the fen. The Fe, Mn, and Co maxima at the base of the peat are associated with a maximum in detrital matter content of the peat. The chemistry of sediments and groundwater collected beneath the peat indicate that mobilization of metals from sulfide minerals in the buried mineral deposit or glacial deposits is minimal. Therefore, the primary source of Cu to the peat at the study site is outcrops and shallow subcrops of the mineral deposit adjacent to the fen. (Author's abstract)
W91-05050

SEASONAL FLUCTUATIONS IN THE CHEMISTRY OF SMALL FOREST LAKES IN SOUTHERN FINLAND WITH SPECIAL REFERENCE TO ACIDITY.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 2H.
W91-05066

KINETICS OF SELENATE AND SELENITE ADSORPTION/DESORPTION AT THE GOETHITE/WATER INTERFACE.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5B.
W91-05075

DETERMINATION OF RHENIUM IN GROUNDWATER BY INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY WITH ON-LINE CATION EXCHANGE MEMBRANE SAMPLE CLEANUP.
National Enforcement Investigations Center, Denver, CO.
For primary bibliographic entry see Field 5A.
W91-05091

DETERMINATION OF LINEAR ALKYLBENZENESULFONATES AND DIALKYLTETRALINSULFONATES IN WATER AND SEDIMENT BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY.
Monsanto Co., St. Louis, MO.
For primary bibliographic entry see Field 5A.
W91-05092

LIQUID CHROMATOGRAPHY-ELECTROCHEMICAL DETECTION OF INORGANIC ARSENIC USING A WALL JET CELL WITH CONVENTIONAL AND MICROSIZED PLATINUM DISK ELECTRODES.
Deakin Univ., Melbourne (Australia). Div. of Chemical and Physical Sciences.
For primary bibliographic entry see Field 5A.
W91-05093

KINETICS AND MECHANISMS OF SULFATE ADSORPTION/DESORPTION ON GOETHITE USING PRESSURE-JUMP RELAXATION.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
P. C. Zhang, and D. L. Sparks.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1266-1273, September/October 1990. 2 fig, 39 ref, append.

Descriptors: *Weathering, *Leaching, *Adsorption, *Desorption, Path of pollutants, *Soil chemistry, *Sulfates, *Adsorption kinetics, *Goethite, Iron compounds, Mathematical models, Model studies, Pressure-jump relaxation, Electrostatics, Equilibrium.

Adsorption of sulfate on soils and soil constituents has been extensively studied, particularly as it affects various aspects of plant nutrition, soil acidity, soil salinity, and water quality. Sulfate adsorption/desorption on goethite in aqueous suspension was investigated thermodynamically and kinetically. The sulfate adsorption isotherm indicated that adsorption decreased with increased pH of the goethite suspension. The triple-layer model fit the experimental data well when adsorbed sulfate was assumed to be located at the beta plane and held via outer-sphere complexation. Pressure-jump relaxation was used to determine the kinetics of sulfate adsorption/desorption on goethite. A single relaxation was observed due to adsorption/desorption processes. Based on the equilibrium and kinetic studies, two reaction mechanisms for sulfate retention were hypothesized and tested. The first postulated mechanism assumed that sulfate was adsorbed on a positively charged surface site through electrostatic attraction. This mechanism was rejected because of the poor conformity between the intrinsic equilibrium constant determined from the static studies and that found from the ratio of forward and backward rate constants. The adsorption of sulfate on goethite occurred simultaneously with the protonation of a neutral surface site, as assumed in the second hypothesized mechanism. Based on this mechanism, a linear relationship between the reciprocal relaxation time and various concentration terms was observed. Forward and backward rate constants were calculated (202,000,000 /sq mol/sq L/sec and 0.144/sec, respectively). The intrinsic equilibrium constant from kinetic measurements was 10 to the 9.14 power/sq mol/ sq L, which was similar to the intrinsic equilibrium constant from the equilibrium studies (10 to the 9.60 power). (Author's abstract)
W91-05178

ANALYSES OF ADSORPTION KINETICS USING STIRRED-FLOW CHAMBER: II. POTASSIUM-CALCIUM EXCHANGE ON CLAY MINERALS.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
M. J. Eick, A. Bar-Tal, D. L. Sparks, and S. Feigenbaum.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1278-1282, September/October 1990. 7 fig, 19 ref.

Descriptors: *Analytical techniques, *Clay minerals, *Soil chemistry, *Adsorption kinetics, *Calcium, *Potassium, *Cation exchange, Vermiculite, Montmorillonite, Soil types, Stirred-flow chamber, Flow discharge rates, *Adsorption.

Potassium-calcium adsorption kinetics on a Llano vermiculite and an Arizona montmorillonite were studied using a stirred-flow technique. Various experiments were conducted to distinguish between (1) instantaneous equilibrium and time-dependent reactions, and (2) solution-concentration-dependent kinetic models vs. those that are independent of solution concentration. These experiments included varying the flow rate and influent concentration and stopping the flow for a period of time. Results showed that potassium-calcium exchange on montmorillonite was too rapid to be measured with the stirred-flow technique, while exchange rates on vermiculite could be ascertained. Adsorption kinetic parameters should be included in transport models to more accurately predict the fate of ions

in soils dominated by vermiculitic and micaceous clay minerals. (Author's abstract)
W91-05179

FLUORESCENCE QUENCHING AND POLARIZATION STUDIES OF NAPHTHALENE AND 1-NAPHTHOL INTERACTION WITH HUMIC ACID.
Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.
For primary bibliographic entry see Field 5B.
W91-05180

FLUORESCENCE SPECTROSCOPY OF AQUEOUS LEAF LITTER EXTRACTS AND THEIR COMPLEXES WITH ALUMINUM.
Bern Univ. (Switzerland). Geological Inst.
W. Shotyk, and G. Sposito.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1305-1310, September/October 1990. 5 fig, 1 tab, 30 ref. NSF Grant CES-8896204.

Descriptors: *Litter, *Analytical techniques, *Acid rain effects, *Soil organic matter, *Metal complexes, *Soil chemistry, *Fluorometry, *Aluminum, Leaves, *Spectroscopy, Leaf litter, Absorption spectra, Organic matter, Hydrogen ion concentration.

Fluorescence spectroscopy is a sensitive method for discriminating among humic substances both in structure and in provenance. This study was conducted to determine whether the same is true for an important nonhumic organic material, the water-soluble fraction of forest leaf litter. Aqueous extracts of leaf litter from three tree species (Castanea sativa, Pinus monticola, Salix spp.) were examined by conventional excitation and synchronous-scan excitation fluorescence spectroscopy. The spectra obtained varied with the plant source of the leaf litter extract (LLE) as well as with the LLE concentration. This sensitivity to organic matter origin indicates that fluorescence spectroscopy will be useful to distinguish among LLE of differing provenance. The synchronous-scan spectra of the LLE showed some peaks that decreased in relative intensity with increasing LLE dilution, and some that increased with increasing dilution. This behavior was attributed to the presence of both Type I fluorophores, which are not quenched because they do not form charge-transfer complexes with nonfluorescent constituents of the LLE, and Type II fluorophores, which are quenched by the formation of charge-transfer complexes and self-quenching processes, leading to intensity increases at high dilution. Synchronous-scan excitation spectra also were obtained for aluminum/LLE mixtures at pH 4.5, with the total aluminum concentration varying from 0 to 60 mmol/cubic m. The spectra showed that aluminum-complex formation may result either in increases of relative fluorescence intensity or in fluorescence quenching, depending both on the source of LLE and on its concentration. This result may reflect a concentration dependence of charge-transfer complex formation and the possibility that excited-state complexes of aluminum are less fluorescent that ground-state aluminum complexes. (Author's abstract)
W91-05181

HABITAT-SPECIFIC SOLUTE RETENTION IN TWO SMALL STREAMS: AN INTERSITE COMPARISON.
Georgia Univ., Athens. Inst. of Ecology.
N. L. Munn, and J. L. Meyer.
Ecology ECOLAR, Vol. 71, No. 6, p 2069-2082, December 1990. 2 fig, 6 tab, 59 ref. NSF Grant BSR 8514328.

Descriptors: *North Carolina, *Oregon, *Dissolved organic carbon, *Water chemistry, *Headwater streams, *Mountain streams, *Nutrient concentrations, Phosphorus, Nitrates, Calcium, Watersheds, Particulate matter, Nitrogen demand, Ecosystems, Detritus, Sediments.

Uptake rates of P (phosphorus), nitrate, Ca (calcium), and dissolved organic carbon within two headwater streams, one in the Appalachian mountains of North Carolina and the other in the Cascade range of Oregon were measured. The major physical differences between these two streams are parent geology and local geomorphic structure. Uptake rates were measured following low-level nutrient releases during summer 1987 in 20-m reaches with different geomorphology. Nitrate-N uptake rates were high for the western stream and low for the eastern stream during the summer. The debris dam reaches in Oregon were the most retentive of N. Conversely, soluble reactive phosphorus (SRP) uptake rates were higher for the eastern stream primarily through biotic processes. SRP uptake lengths were short for the cobble (32m), debris dam (35m) and rock outcrop (40m) reaches in the eastern stream. Uptake of SRP in either stream was not related to sediment size fraction but rather to a combination of sediment infiltration rates and quality of organic material. Ca uptake lengths were long in the Oregon stream (1278 m) but short in the Appalachian stream (106 m). The eastern stream was more retentive of Ca than nitrate. Debris dams greatly enhanced retention of dissolved organic carbon in both streams although retention was greater in the eastern stream. The lower uptake rate of P and higher uptake rate of nitrate in the Oregon stream were expected; streams in this area drain catchments of volcanic origin and tend to have low N:P ratios indicating potential N limitation. Streams flowing over granitic bedrock, such as the eastern stream, tend to have lower P availability. The combined results of laboratory and field measurements indicate that in the eastern stream, strong biotic control of P uptake coupled with high P demand result in relatively short P uptake lengths and a strong impact of P spiraling on ecosystem dynamics. In the western stream, strong biotic control of N uptake combined with strong N demand result in short N uptake lengths. This is especially true at sites of downed timber that retain both fine and coarse particulate organic matter, creating a high N demand. (Author's abstract)
W91-05201

PROPERTIES OF SURFACE WATERLOGGED CLAY SOILS CONTAINING EXCHANGEABLE MG.
Polytechnic Institute, Sofia, Bulgaria.
For primary bibliographic entry see Field 2G.
W91-05228

SALINE MARITIME SOILS OF ESTONIA.
Tallinn Botanical Garden (USSR).
For primary bibliographic entry see Field 2G.
W91-05229

ORTSTEINS IN SOD-CALCAREOUS LEACHED AND SOD-GLEY CALCAREOUS SOILS ON PERMIAN CLAY ELUVIUM.
Akademiya Nauk SSSR, Moscow. Pochvennyi Inst.
A. D. Startsev.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 32-38, 1990. 1 fig, 3 tab, 12 ref.

Descriptors: *Geochemistry, *Calcarcaveous soils, *Mangananese, *Soil chemistry, Soil classification, *Leaching, Ortsteins, Hydrogen ion concentration, Soil physical properties, Waterlogging, Hydrological regime.

The morphology, distribution through the profile, and composition of iron-manganese ortsteins in sod-calcareous leached and sod-gley calcareous soils on Permium calcareous clay eluvium within a geochemical catena are investigated. The physicochemical segregation of the variable-valence elements must involve not only redox conditions, but also pH. The role of the pH increases considerably when a close correlation exists between pH and the hydrologic regime. In contrast to the soils of the Podzolic series in the non-Chernozem center, the waterlogging of soils forming on Permian calcareous eluvium causes simultaneous accumulation of iron and manganese. The morphology and properties of the ortsteins in these soils, although complicating the practical use of the waterlogging coefficient for quantitative identification, are still of great diagnostic value. (Brunone-PTT)
W91-05230

COMPARISON OF MODELS OF PHOSPHATE SORPTION BY SOILS.
Vsesoyuznaya Akademiya Sel'skokhozyaystvennykh Nauk, Leningrad (USSR). Agrofizicheskii Nauchno-Issledovatel'skii Inst.
D. F. P. Fernandez, and O. G. Us'yarov.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 66-71, 1990. 3 fig, 2 tab, 11 ref.

Descriptors: *Sorption, *Nutrient transport, *Soil chemistry, *Cuba, Cultivated lands, Comparison studies, *Model studies, *Phosphates, Mathematical models, Cation exchange, Resins, Equilibrium.

The isotherms for sorption of phosphate by cultivated cinnamon brown soils of Cuba are investigated and measurements are compared with the Langmuir, Freundlich, Temkim, and Gunary equations for the sorption isotherm, correcting for sorbed phosphorus originally present. The best agreement between the measurements and calculations in the concentration range is obtained with the Gunary equation, with the initial amount of phosphate determined with ion exchange resins. None of the equations, however, express the complex character of the surface interactions of phosphate ion in the double ionic layer, i.e., dispersive, electrostatic, and polarizational, and the associated changes in the potential of the Stern layer and in the ion exchange potential when the concentration of the equilibrium solution is varied. (Brunone-PTT)
W91-05231

EFFECT OF FERTILIZER PHOSPHATES ON SOLUBILITY OF CA, MG, MN, AL, AND FE COMPOUNDS IN GRAY FOREST SOIL.
Institute of Applied Physics, Pushkino (USSR).
A. Y. Kudeyarova, and M. Z. Kvaratskheliya.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 56-65, 1990. 1 fig, 2 tab, 26 ref.

Descriptors: *Aluminum, *Calcium, *Iron, *Magnesium, *Manganese, *Forest soils, *Fertilizers, *Phosphates, Solubility, Trace elements, *Soil chemistry, Nutrient concentrations, Ligands, Groundwater movement, Metals.

The effect of fertilizer phosphates on the solubility of soil compounds containing calcium, magnesium, manganese, zinc, aluminum, and iron as a function of their complexing ability was investigated. The extent and duration of solubilization depended on the metal and on the nature of the phosphate complexes that were formed. The increased solubility of soil compounds in the presence of phosphate fertilizers resulted in the migration of the metals into the lower soil layers as newly formed complexes. The ligand activity of phosphates depends on the amount present in the soil, the amount of condensed forms, and the relative amounts of other ligands in the soil. The combined effect of the organic substances entering the soil in root secretions and of relatively small applications of phosphates was to decrease the migrational ability of the metals compared with the fallow soil. The results of this study indicate that the effect of phosphate fertilizers differs with the level of application, the percentage of condensed forms, the presence or absence of other ligands in the soil and their activities, the particular metals and their concentrations, and their affinities for specific ligands. (Brunone-PTT)
W91-05232

RAPID ION-EXCHANGE TECHNIQUE FOR THE SEPARATION AND PRECONCENTRATION OF CHROMIUM(VI) AND CHROMIUM(III) IN FRESH WATERS.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5A.
W91-05332

ION CHROMATOGRAPHIC DETERMINATION OF TRACE AMOUNTS OF ALUMINIUM

WITH ON-LINE PRECONCENTRATION AND SPECTROPHOTOMETRIC DETECTION.
Padua Univ. (Italy). Dipt di Chimica Inorganica, Metallorganica e Analitica.
For primary bibliographic entry see Field 5A.
W91-05333

PRODUCTION AND STABILITY OF ETHYLENE IN SOIL.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 2G.
W91-05337

EQUATIONS TO CALCULATE THE APPROXIMATE DURATION AND TERMINATION OF THE MAXIMAL RATE PHASE OF NITRIFICATION IN SOIL.
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-05342

BIOGEOCHEMISTRY OF NITROGEN IN AGRICULTURAL LANDSCAPES.
Institut Fotosinteza, Pushkino SSR).
For primary bibliographic entry see Field 2G.
W91-05349

NATURE AND MECHANISMS OF FORMATION OF METAL-HUMUS COMPLEXES.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05350

CALCULATION OF MASS-EXCHANGE PROCESSES IN LEACHED SOILS.
Volga Inst. of Hydraulic Engineering and Melioration, Engel's (USSR).
For primary bibliographic entry see Field 2G.
W91-05353

MODELING OF MASS-EXCHANGE OF PHASES IN A SOLONETZIC SOIL LEACHED AFTER APPLICATION OF GYPSUM.
Akademiya Nauk SSSR, Moscow. Inst. of Soil Science and Photosynthesis.
For primary bibliographic entry see Field 2G.
W91-05354

SOLUBILITY AND HYDROLYSIS OF AQUEOUS ALUMINIUM HYDROXIDES IN DILUTE FRESH WATERS AT DIFFERENT TEMPERATURES.
Norges Landbrukshoegskole, Aas. Isotope Lab.
For primary bibliographic entry see Field 5C.
W91-05383

ELEVATED NITRATE LEVELS IN SOILS OF THE EASTERN MOJAVE DESERT.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
D.J. Marrett, R. A. Khattak, A. A. Elseewi, and A. L. Page.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 658-663, Oct-Dec 1990. 4 fig, 2 tab, 30 ref.

Descriptors: *Deserts, *Geochemistry, *Mojave, *Nitrates, *Saline soils, *Soil chemistry, Alluvial deposits, Arid lands, Caliche, Correlation analysis, Leaching, Salinization, Soil cores.

Deep cores taken on an uncultivated desert alluvial fan revealed two large volumes of coarse soil with high NO3 levels (20-208 mg/L NO3-N in water saturation extracts). Nitrate levels were unpredictable both laterally and vertically and unrelated to alluvial strata. The large soil volumes with elevated NO3 levels were found 2.7 to 7.3 m deep in four cores at one 3 by 3 m site, and 8.8 to 21 m deep in two cores at another site. Isolated samples with elevated NO3 were found in three other cores and six cores contained no elevated NO3. Overall, nitrate was best correlated with salinity, Na, SO4, and Cl (r = 0.68, 0.66, 0.67, and 0.73 respectively; P less than or equal to 0.05). Stronger correlations were found within the four individual sites and fifteen cores, but the ions best correlated with NO3 varied, even between cores from the same site. Saturation extract NO3 was not correlated with bulk soil total organic carbon or total nitrogen. The NO3 distribution patterns found appear related to inorganic processes (salinization and leaching), but specific processes of N redistribution and primary N sources remain unclear. Elevated NO3 in deep soils appears to be a natural phenomenon that reflects Pleistocene site conditions and possible geologic NO3 sources. Local volcanic rocks contain up to 73 mg NO3-N/kg of rock (water extractable). Naturally elevated NO3 levels in rocks and course alluvial fan soils are poorly understood and easily overlooked potential sources of underground NO3. (Author's abstract)
W91-05395

INTERFERENCE OF SOLUBLE SILICA IN THE DETERMINATION OF ORTHOPHOSPHATE-PHOSPHORUS.
Bologna Univ. (Italy). Inst. of Agricultural Chemistry.
For primary bibliographic entry see Field 5A.
W91-05407

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: LONG-TERM RECONSTRUCTIONS AT TWO SITES IN CENTRAL SCOTLAND.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5C.
W91-05436

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: AN ASSESSMENT OF THE RELATIVE EFFECTS OF ACID DEPOSITION AND AFFORESTATION.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5C.
W91-05437

GEOCHEMICAL CALCULATIONS AND OBSERVATIONS ON SALT WATER INTRUSIONS: II. VALIDATION OF A GEOCHEMICAL MODEL WITH LABORATORY EXPERIMENTS.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 2F.
W91-05440

ORGANIC CARBON ISOTOPE GEOCHEMISTRY OF CLAYEY DEPOSITS AND THEIR ASSOCIATED POREWATERS, SOUTHERN ALBERTA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2G.
W91-05441

CURVES OF CHEMICAL FLUX VERSUS DISCHARGE AND WORKING OF KARST AQUIFERS (LES COURBES FLUX CHIMIQUE-DEBIT ET LE FONCTIONNEMENT DES AQUIFERES KARSTIQUES).
Centre Univ. d'Avignon (France). Hydrogeology Lab.
For primary bibliographic entry see Field 2F.
W91-05443

EFFECT OF HIGH SALT CONCENTRATIONS ON OZONE DECOMPOSITION IN WATER.
Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica.
For primary bibliographic entry see Field 5F.
W91-05465

DETERMINATION OF EXCHANGEABLE SODIUM STATUS OF SALT-AFFECTED SOILS AND ITS RELATIONSHIP WITH GROWTH OF PLANTS.
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils.
J. S. Kalkat, and M. S. Bajwa.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 69-79, 1990. 2 fig, 4 tab, 20 ref.

Descriptors: *Agriculture, *India, *Plant growth, *Saline soils, *Sodium, *Soil chemistry, *Soil-water-plant relationships, Crops, Mathematical studies, Model studies, Soil solution.

Characterization of the extent of sodium saturation on the soil exchange complex becomes important when chemical amelioration of sodic soils is necessary. The exchangeable sodium percentage (ESP) is either determined by direct ammonium acetate method or predicted by using empirical methods involving the concept of sodium absorption ratio (SAR) in soil solution. The direct methods are time consuming and are not very precise due to several sources of error. Thus, the empirical methods involving SAR have been extensively used to predict the ESP of salt-affected soils. The validity of the SAR concept has also been questioned because of the anomalous behavior of the SAR-ESP and SAR-ESR relationships caused by the variable soil solution values resulting from mineral dissolution. These points emphasize the need for a dependable sodicity parameter. The validity of the SAR concept and its limitations for the prediction of ESP of some calcareous saline-sodic soils of Punjab were studied. Exchangeable sodium percentages determined by the direct ammonium acetate method were related with ESP predicted by empirical methods based on ESR-SAR relationships. The relationship between soil sodium saturation, determined by different methods, with the growth and sodium content of plants was also studied. Deviations of the observed and predicted ESR and ESP values were noted in soils testing high in SAR and salinity. The values of Gapon's selectivity coefficient (Kg) varied with salinity, saturation percentage, clay and cation exchange capacity of the soils. Results of a greenhouse experiment showed that the sodicity effects on rice, wheat, barley, maize and clover could be expressed better in terms of SAR or ESP determined by different methods. (Agostine-PTT)
W91-05477

INFLUENCE OF SEA SALT AEROSOLS AND LONG RANGE TRANSPORT ON PRECIPITATION CHEMISTRY AT EL VERDE, PUERTO RICO.
State Univ. of New York Coll. at Oswego. Research Center.
For primary bibliographic entry see Field 5B.
W91-05492

EFFECT OF SOLUTION PH, EXTERNAL CALCIUM CONCENTRATION, AND ALUMINUM ACTIVITY ON NODULATION AND EARLY GROWTH OF COWPEA.
Queensland Univ., Brisbane (Australia). Dept. of Agriculture.
For primary bibliographic entry see Field 2I.
W91-05495

UREA LOSSES IN FLOODED SOILS WITH ESTABLISHED OXIDIZED AND REDUCED SOIL LAYERS.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
For primary bibliographic entry see Field 3F.
W91-05554

DEVELOPMENT OF A MICROBIAL COMMUNITY ON CELLULOSE BURIED IN WATER-LOGGED SOIL.
Tokyo Univ. (Japan). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 2G.
W91-05555

SOIL WATER EFFECTS ON THE USE OF HEAT UNITS TO PREDICT CROP RESIDUE

CARBON AND NITROGEN MINERALIZATION.
Agricultural Research Service, Orono, ME. New England Plant, Soil and Water Lab.
For primary bibliographic entry see Field 2G.
W91-05556

GEOCHEMISTRY OF BLACK WATER IN SELECTED COASTAL STREAMS OF THE SOUTHEASTERN UNITED STATES.
Georgia Univ., Athens. Dept. of Agronomy.
For primary bibliographic entry see Field 2H.
W91-05562

VARIATIONS IN CHEMICAL COMPOSITION OF THE SOIL SOLUTION OVER A FOUR-YEAR PERIOD AT AN UPLAND SITE IN SOUTHWEST SCOTLAND.
Stirling Univ. (Scotland). Dept. of Environmental Science.
For primary bibliographic entry see Field 2G.
W91-05564

MINERALOGICAL IMPLICATIONS OF HIGH RATIOS OF 1500 KPA WATER CONTENT TO PERCENT MEASURED CLAY FOR TWO SOILS OF WESTERN NEBRASKA.
Nebraska Univ.-Lincoln. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-05567

GROUNDWATER DILUTION AND RESIDENCE TIMES, AND CONSTRAINTS ON CHLORIDE SOURCE, IN THE MOKAI GEOTHERMAL SYSTEM, NEW ZEALAND, FROM CHEMICAL, STABLE ISOTOPE, TRITIUM, AND 36-CL DATA.
Geological Survey of Japan, Tsukuba. Mineral Resources Dept.
For primary bibliographic entry see Field 2F.
W91-05570

MODIFIED MOST-PROBABLE-NUMBER TECHNIQUE FOR THE SPECIFIC DETERMINATION OF ESCHERICHIA COLI FROM ENVIRONMENTAL SAMPLES USING A FLUOROGENIC METHOD.
Malaga Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W91-05572

INVESTIGATION OF HYDROGEN PEROXIDE CHEMISTRY IN SURFACE WATERS OF VINEYARD SOUND WITH H2-18O2 AND 18O2.
Woods Hole Oceanographic Institution, MA. Dept. of Chemistry.
J. M. Moffett, and O. C. Zafiriou.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1221-1229, September 1990. 6 fig, 1 tab, 17 ref. Office of Naval Research Contracts N000-14-85-C-001, and NC0001-14-87-K-0007.

Descriptors: *Hydrogen peroxide, *Oxygen isotopes, *Surface water, *Water chemistry, Biodegradation, Coastal waters, Decomposition, Enzyme activity, Light intensity, Metabolism, Photochemistry.

Oxygen-18 labeled hydrogen peroxide and oxygen have been used to determine abundance rates and pathways of peroxide formation and decay processes in surface waters of a coastal marine site. Reactions were followed by incubating seawater samples with oxygen-18 labeled oxygen or oxygen-18 labeled hydrogen peroxide and following the chemical transformation of the isotope label. Decomposition of oxygen-18 labeled hydrogen peroxide was dominated by biological processes and led to the formation of oxygen-18 labeled oxygen and oxygen-18 labeled water; the product distribution indicates that 65 to 80% of the decay was due to catalase with 20 to 35% due to peroxidase activity. Photochemical oxidation of oxygen-18 labeled hydrogen peroxide to oxygen-18 labeled oxygen was also observed. Particle dependent, light-independent peroxide production was also observed in freshly collected samples, with rates ranging from 0.8 to 2.4 nM/h. These rates are low relative to photochemical production rates in surface waters, but may be important under conditions of low light intensity. Experiments with a metabolic inhibitor suggest that at least some of this production was biologically mediated. However, there was no evidence for light-dependent biological production. (Author's abstract)
W91-05577

SULFUR CYCLE OF FRESHWATER SEDIMENTS: ROLE OF THIOSULFATE.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2H.
W91-05583

CHEMICAL AND STABLE ISOTOPIC CHARACTERISTICS OF GROUND WATER ON GRAND CAYMAN.
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-05653

WATER QUALITY OF A CARBONATE ISLAND KARST AQUIFER, SAN SALVADOR ISLAND, BAHAMAS.
Mississippi State Univ., Mississippi State. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2F.
W91-05654

BASELINE WATER-QUALITY EVALUATION OF THREE BASINS IN THE UPPER RIO GRANDE DE ARECIBO BASIN, PUERTO RICO.
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 5B.
W91-05655

AQUEOUS GEOCHEMISTRY OF THE SAND-AND-GRAVEL AQUIFER, NORTHWEST FLORIDA.
Geological Survey, Tallahassee, FL.
B. G. Katz, and A. F. Choquette.
Ground Water GRWAAP, Vol. 29, No. 1, p 47-55, January/February 1991. 5 fig, 3 tab, 36 ref.

Descriptors: *Florida, *Geochemistry, *Groundwater chemistry, *Water chemistry, *Water quality, Aquifers, Geohydrology, Gravel, Hydrologic budget, Mineralogy, Monitoring, Monitoring wells, Rainfall, Saline water, Sand.

The aqueous geochemistry of the sand-and-gravel aquifer in northwest Florida was characterized as part of the Florida Groundwater Quality Monitoring Network Program, a multiagency cooperative study delineating baseline and/or background water quality for the major aquifer systems throughout the state. The aquifer is the principal source of water in northwest Florida and consists predominantly of quartz sand with smaller amounts of andesine, chlorite, calcite, kaolinite, and illite. Water from 42 wells in the sand-and-gravel aquifer sampled during 1986 and 1987 was characteristically low in dissolved solids (median value of 72 mg/l) and of nondistinct water type, although relative concentrations of magnesium and sulfate tended to be lower than those of other major ions. Nonparametric statistical tests of major-ion concentration variations with depth and relative distance along flow paths indicate that the water chemistry does not change significantly ($p = 0.05$) as the water moves vertically and laterally through the aquifer. Mass-balance calculations indicate that dissolved solids from rainfall and saline-water sources each account for 13% of the concentration of dissolve solids in groundwater. Incongruent dissolution of andesine, chlorite, and muscovite to form kaolinite accounts for 94% of the neutralization of the total hydrogen ion input from rainfall and from carbonic acid weathering in the subsurface. The remaining neutralization is accounted for by the dissolution of calcite. (Author's abstract)
W91-05820

SOLUTE REJECTION IN FREEZING SOILS.
HydroGeoLogic, Inc., Herndon, VA.
S. Panday, and M. Y. Corapcioglu.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 99-108, January 1991. 7 fig, 1 tab, 34 ref, 2 append. NSF Grant ECE-8602849.

Descriptors: *Freezing, *Frozen ground, *Mathematical models, *Model studies, *Saline soils, *Solute rejection, Capillarity, Energy, Frost heaving, Interstitial water, Mathematical equations, Performance evaluation, Soil temperature, Temperature, Thermal conductivity.

Dissolved compounds in the water phase are rejected during freezing of soils. This phenomenon occurs because ice crystals cannot incorporate most alien molecules. The ice grows only by association with water molecules; molecules of solutes are rejected into unfrozen water. A mathematical model for salt rejection in freezing saline soils was developed by employing the mass balance equations for water and solute in a saturated porous medium and the conservation of energy equation. Additional relations introduced included a moisture retention curve as a function of ice-water capillary pressure, the Clapeyron equation and expressions for the heat capacity and the effective thermal conductivity of the soil. The resulting set of seven equations in terms of solute concentration, soil temperature, pore water, ice, and capillary pressures, as well as degrees of water and ice saturation were solved simultaneously using Newton-Raphson linearization, with implicit iterative treatment of nonlinearities. Results indicate the development of unfrozen high salt concentration regions trapped in a frozen zone at sufficiently high freezing rates. The numerical results were compared with experimental data and a favorable match was obtained between theoretical and experimental results. The model makes the assumption that the soil does not deform (heave). The equations can be modified for a deforming system. (Author's abstract)
W91-05840

ORIGIN AND MORPHOLOGY OF LIMESTONE CAVES.
State Univ. of New York Coll. at Oneonta. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W91-05851

CHEMICAL ANALYSIS OF RAIN SAMPLES COLLECTED OVER THE PACIFIC OCEAN.
National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs.
C. Nagamoto, F. Parungo, B. Kopcewicz, and M. Y. Zhou.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 13, p 22, 343-22,354, December 20, 1990. 7 fig, 1 tab, 26 ref.

Descriptors: *Acid rain, *Air pollution, *Chemical analysis, *Chemistry of precipitation, *Pacific Ocean, *Path of pollutants, *Weather data collections, Aerosols, Calcium, Chlorides, Cloud physics, Hydrologic cycle, Magnesium, Marine climates, Marine pollution, Nitrates, Potassium, Sodium, Sulfates, Water chemistry, Wet deposition.

The ocean is a major source and sink for atmospheric aerosols and gases and the hydrological cycle is a major pathway for air-sea exchange of trace species. Investigation of marine precipitation chemistry can improve understanding of biogeochemical cycling, which is of great importance to global climate change. During seven research cruises in the Pacific Ocean from 1984 to 1989, rain samples were collected for chemical analysis. The geographical and temporal variations of rain chemistry were studied in relation to natural and anthropogenic sources and transport of the constituents. The pH values of rain samples ranged from 3.9 to 7.2, with a mean of 5.6. The most acidic rain was found near the big ports, where SO4(-2) and NO3(-) concentrations in rain were also the highest. The data indicated that wet deposition transports anthropogenic pollution from continents to oceans.

Enrichments of Ca(+2) and K(+), which were compared to Na(+) in seawater, were observed in all rain samples throughout the ocean. However, their enrichment factors (EF) decrease with distance from land, signifying the extent of transport of crustal elements through cloud process and wet deposition. The EFs of Mg(+2) were close to unity, indicating its common origin with Na(+). The EFs of Cl(-) in most rain samples were less than 1, indicating loss of Cl(-) in aerosols, cloud droplets, or rain drops. High EFs of SO4(-2) were also observed at the equatorial regions, where biogenic production of dimethyl sulfide is well known. During the 1987 El Nino anomaly, low concentrations of sulfate aerosol in the central equatorial region allowed cloud drops to grow more rapidly to precipitable size, increasing the chance of rainfall. However, the drought conditions and higher sulfate concentrations in the western Pacific Ocean decreased precipitation probability. This cloud microphysical effect of the presence of sulfate aerosols on cloud evolution and precipitation deserves further investigation. (Author's abstract)
W91-05862

BERYLLIUM-7 AND LEAD-210 IN THE ATMOSPHERE AND SURFACE SNOW OVER THE GREENLAND ICE SHEET IN THE SUMMER OF 1989.
New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space.
J. E. Dibb.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 13, p 22,407-22,415, December 20, 1990. 4 fig, 3 tab, 45 ref. National Science Foundation grant DPP-8821960.

Descriptors: *Atmospheric chemistry, *Atmospheric circulation, *Climatic changes, *Glaciers, *Global warming, *Greenland, *Ice cover, *Isotope studies, *Path of pollutants, Aerosols, Air pollution, Beryllium radioisotopes, Chemistry of precipitation, Climatic data, Lead radioisotopes, Polar regions, Snow cover.

It is well established that polar ice records large-scale changes in atmospheric chemistry like those resulting from steadily increasing anthropogenic emissions and circulation patterns, but the details of the relationship between the chemistry of present day snow and the atmosphere are unclear. The concentrations of 7-Be and 210-Pb were measured in surface air and fresh and aging snow samples from Summit and Dye 3, Greenland, during June and July 1989. The aerosol concentrations of these radionuclides showed rapid variations at both sites, but were nearly twice as high, on average, at Summit. Concentrations in the 16 fresh snowfall events that were sampled also showed wide variability, but the averages were the same at the two sites. The apparent difference in air-snow fractionation and the lack of coherence in the concentration in air time series between the two sites indicate a previously unsuspected complexity in atmospheric dynamics over the ice sheet. An improved understanding of atmospheric processes, and how the results of those processes are recorded in snow and ice, is crucial for the full interpretation of information about past atmospheric chemistry and climate contained in the snow and ice of glaciers around the world. (Author's abstract)
W91-05864

PHYSICAL AND CHEMICAL CONTROLS OF PREFERRED PATH FLOW THROUGH A FORESTED HILLSLOPE.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 2G.
W91-05882

EFFECT OF SOLUTE APPLICATION METHOD ON PREFERENTIAL TRANSPORT OF SOLUTES IN SOIL.
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-05890

SOLUBLE METALS IN THE ATMOSPHERE AND THEIR BIOLOGICAL IMPLICATIONS: A STUDY TO IDENTIFY IMPORTANT AEROSOL COMPONENTS BY STATISTICAL ANALYSIS OF PIXE DATA.
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 5C.
W91-05894

2L. Estuaries

NOVEL CHLORINATED TERPHENYLS IN SEDIMENTS AND SHELLFISH OF AN ESTUARINE ENVIRONMENT.
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 5B.
W91-04952

EFFECTS OF NITRATE, AMMONIUM AND SALINITY ON GROWTH OF THE MANGROVE BRUGUIERA GYMNORRHIZA (L.) LAM.
Durban-Westville Univ. (South Africa). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W91-04987

ECOLOGY OF NERITINA GLABRATA IN LAGOS LAGOON, NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W91-05002

ASSESSING THE IMPACT OF TIN AND TBT IN ESTUARIES AND COASTAL REGIONS.
Plymouth Marine Lab. (England).
For primary bibliographic entry see Field 5C.
W91-05046

MICROPHYTOBENTHIC CELL DENSITY AND SPECIES COMPOSITION IN THE SURFACE SEDIMENT IN A SHALLOW BRACKISH-WATER BAY (GULF OF FINLAND).
Uppsala Univ. (Sweden). Inst. of Ecological Botany.
For primary bibliographic entry see Field 2H.
W91-05067

ESTIMATION OF POLYCHLORINATED DIBENZOFURAN AND DIBENZO-P-DIOXIN CONTAMINATION OF A COASTAL REGION USING ISOMER PROFILES IN CRABS.
Norsk Inst. for Luftforskning, Lillestroem.
For primary bibliographic entry see Field 5B.
W91-05074

UPSTREAM EXTENT OF SALINE WATER IN THE PASCAGOULA RIVER.
For primary bibliographic entry see Field 6G.
W91-05148

INFLUENCE OF THE SEASONS AND CLIMATIC VARIATIONS ON THE FISH POPULATIONS OF A TROPICAL LAGOON IN WEST AFRICA, (INFLUENCE DES SAISONS ET DES VARIATIONS CLIMATIQUES SUR LES PEUPLEMENTS DE POISSONS D'UNE LAGUNE TROPICALE EN AFRIQUE DE L'OUEST).
Institut Francais de Recherche Scientifique pour le Developpement en Cooperation, Montpellier. Centre de Montpellier.
J.-J. Albaret, and J.-M. Ecoutin.
Acta Oecologica, Vol. 11, No. 4, p 557-583, 1990. 10 fig, 6 tab, 44 ref. English summary.

Descriptors: *Estuarine environment, Ecosystems, *Climatic change, *Seasonal variation, *Fish populations, *Species diversity, *Brackish water, *West Africa, *Lagoons, Climates, Temporal distribution, Species composition, Rainfall, Marine environments.

Fish communities of a bay located in the maritime sector of a tropical brackish water lagoon were studied to determine seasonal and climatic effects on the ecology of this mixed continental and oceanic system. On an annual cycle, as well as a larger time scale (1962 to 1981), a group composed of about twenty species with high ecophysiological capacities formed the core of the fish community in an extremely variable (at several spatio-temporal levels) environment. Besides the persistence of this species group, an increase in the marine component in the community was observed. This increase was attributed to the general rainfall deficit in the region during the period of the study. The level of structural organization is low in the area of the Ebrie Lagoon, where seasonal changes in the composition and structure of the fish communities are very pronounced. These variations are induced primarily by environmental changes in the abundance and distribution of freshwater inputs. Input volume and the earliness in the season of local rain outweighs the impact of the Comoe river flood, which is mainly derived from the rainfall in the northern Sudan area. (Author's abstract)
W91-05160

ANTICIPATED EFFECTS OF CLIMATE CHANGE ON ESTUARINE AND COASTAL FISHERIES.
Maryland Univ., Cambridge. Horn Point Environmental Labs.
For primary bibliographic entry see Field 2B.
W91-05165

OBSERVATIONAL AND MODEL STUDIES OF PHYSICAL PROCESSES AFFECTING BENTHIC LARVAL RECRUITMENT IN DELAWARE BAY.
Cook Coll., New Brunswick, NJ. Dept. of Marine and Coastal Sciences.
For primary bibliographic entry see Field 8I.
W91-05169

DEVELOPMENT OF A TOXIC ALEXANDRIUM MINUTUM HALIM (DINOPHYCEAE) BLOOM IN THE HARBOUR OF SANT CARLES DE LA RAPITA (EBRO DELTA, NORTHWESTERN MEDITERRANEAN).
Instituto de Ciencias del Mar, Barcelona (Spain).
For primary bibliographic entry see Field 5C.
W91-05171

CIRCADIAN RHYTHMS AND VERTICAL PROFILES IN A SHALLOW MARINE ECOSYSTEM (RITMOS CIRCADIANOS Y PERFILES VERTICALES EN UN ECOSISTEMA LITORAL SOMERO).
Instituto Politecnico de F. P. Maritimo-Pesquero del Estrecho, 11008 Cadiz.
J. M. Forja, A. Gomez-Parra, and J. Blasco.
Scientia Marina, Vol. 54, No. 1, p 9-18, March 1990. 9 fig, 1 tab, 27 ref. English summary.

Descriptors: *Diurnal variation, *Spain, *Dissolved oxygen, *Circadian rhythms, *Marine environment, *Ecosystems, *Vertical distribution, Nutrients, Alkalinity, Hydrogen ion concentration, Ammonium, Model studies, Seasonal variation.

Circadian rhythms and vertical profiles of dissolved oxygen, pH, alkalinity, nutrients (ammonium and silicon dioxide) and other related parameters were studied in the water column of a salt pond located in the south of Cadiz Bay (SW Spain). This study was carried out during the spring and summer of 1985. In spring, vertical gradients of parameters analyzed have little importance and the daily variation of their values are uniform in the water column, and independent of the degree of salt pond water renewal. In summer, oxygen concentration is very variable, ranging from anoxic conditions at the bottom in the early hours to over-saturation values of 180% at the surface after noon. Gradients of up to -3.6 mg oxygen/L/m in only 2.5 m in depth have been detected. The spatio-temporal evolution of pH and ammonium ion concentrations indicate the importance of benthic regeneration of nutrients in these ecosystems. A model for prediction of dissolved oxygen concentration and pH values as a function of depth and time of day is proposed. This model is

valid for spring and summer and its parameters are related to the main processes which affect the dissolved gas content in the ecosystem. (Author's abstract)
W91-05172

INFLUENCE OF TIDAL CONDITIONS AND RIVER VOLUME ON PHYTOPLANKTON DISTRIBUTION AND COMPOSITION IN THE PAS ESTUARY (NORTHERN SPAIN).
Cantabria Univ., Santander (Spain). Lab. de Ecologia.
L. Perez, and J. C. Canteras.
Scientia Marina, Vol. 54, No. 1, p 77-88, March 1990. 6 fig, 5 tab, 28 ref.

Descriptors: *Tidal effects, *Estuarine environment, *Population dynamics, *Stream discharges, Population density, Distribution patterns, Environmental gradient, *Phytoplankton, Algal growth, *Spain, Species composition, Salinity.

Phytoplankton composition and distribution was studied in a small estuary of Cantabria from February to December 1985 under different tidal conditions. 239 species were identified which showed a high degree of tolerance of salinity changes. The volume of the river exerted great control over the selection and abundance of the species. The community consisted of small cells with high growth rates. Species of clearly fluvial influence (Rhoicosphenia curvata, Asterionella formosa, Scenedesmus quadricauda) as well as estuarine species (Skeletonema costatum, Nitzschia closterium, Buddulphia moboliensis) occurred. Tidal conditions did not affect the specific composition of the community, but the number of individuals observed was always greater at low tide. At all times, a downward longitudinal gradient of abundance existed from the innermost to the outermost stations. Variations in the volumes of marine and fresh waters throughout the annual cycle determine the structure of the community. (Author's abstract)
W91-05173

WATER INTERCHANGE BETWEEN THE RIA OF VIGO AND THE COASTAL SHELF.
Instituto de Investigaciones Marinas, Vigo (Spain).
R. Prego, F. Fraga, and A. F. Rios.
Scientia Marina, Vol. 54, No. 1, p 95-100, March 1990. 5 fig, 4 tab, 18 ref.

Descriptors: *Coastal waters, *River mouth, *Spain, *Ria of Vigo, *Estuaries, Salinity, *Water circulation, Seawater, Seasonal variation, Wind effects, Drainage area, Stream discharge.

The water interchange between the Ria of Vigo and the coastal shelf is discussed from the points of view both of salinity and of the fresh water contribution from the drainage basin. In winter results show a typical estuarine circulation, produced by the great quantity of fresh water running into the Ria. This factor causes flows of approximately 2,000,000 kg/sec; 2 m/day upward movement of sea water, and a speed of 3 km/day for the estuarine residual current in the outlet of the Ria. In summer these values decrease to about one sixth of the winter values, although there is an increase in the circulation of up to 1,000,000 kg/sec, the consequence of upwelling produced by north winds over the shelf. Later the south winds produce the opposite effect, blocking interchange with the shelf. The mixing of water in the Ria is greater in the summer, favoring the arrival and recycling of nutrient salts in the area. (Author's abstract)
W91-05174

GUIDELINES FOR VEGETATIVE EROSION CONTROL ON WAVE-IMPACTED COASTAL DREDGED MATERIAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 4D.
W91-05275

PCB AND PCT CONTAMINATION IN WINTER QUARTERS BAY, ANTARCTICA.
California Univ., Santa Cruz. Inst. of Marine Sciences.
For primary bibliographic entry see Field 5B.
W91-05345

METALS AND ORGANIC CONTAMINANTS IN NORTHWEST ATLANTIC DEEP-SEA TILEFISH TISSUES.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
For primary bibliographic entry see Field 5B.
W91-05346

ORGANOCHLORINE COMPOUNDS IN THE PORTUGUESE OYSTER: IMPORTANCE OF SEASONAL VARIATIONS.
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
For primary bibliographic entry see Field 5B.
W91-05348

STUDIES OF A SUBARCTIC COASTAL MARSH. III. MODELLING THE SUBSURFACE WATER FLUXES AND CHLORIDE DISTRIBUTION.
Memorial Univ. of Newfoundland, St. John's. Dept. of Geography.
For primary bibliographic entry see Field 2H.
W91-05427

PARTICLE FLUXES AND ECOSYSTEM RESPONSE ON A CONTINENTAL MARGIN: THE 1985-1988 MEDITERRANEAN ECOMARGE EXPERIMENT.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
For primary bibliographic entry see Field 2J.
W91-05450

MASS-PHYSICAL PROPERTIES OF SURFICIAL SEDIMENTS ON THE RHONE CONTINENTAL MARGIN: IMPLICATIONS FOR THE NEPHELOID BENTHIC LAYER.
Nice Univ. (France).
For primary bibliographic entry see Field 2J.
W91-05451

GULF OF LIONS' HYDRODYNAMICS.
Antenne du Centre d'Oceanologie de Marseille, BP330, F-83507 La Seyne, France.
C. Millot.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 885-894, 1990. 2 fig, 26 ref.

Descriptors: *Continental slope, *Gulf of Lions, *Hydrodynamics, *Mediterranean Sea, Atmosphere, Coastal waters, Fishing, Mathematical models, Satellite technology, Seasonal variation, Stratification, Topography, Upwelling, Water circulation, Wind effects.

The Gulf of Lions can be considered a very complex hydrodynamic region, because several intense and highly variable phenomenon compete simultaneously. These processes include the powerful general circulation along the continental slope, the formation of dense water both on the shelf and offshore, wind-induced upwelling and downwelling a seasonal variation of stratification and the extreme energies associated with meteorological conditions. The cloudless atmospheric conditions encountered generally in the northwestern Mediterranean Sea have allowed over more than 10 years the extensive use of various satellite imageries. The large space and time variability of the hydrodynamical features, a complex topography, and a noticeable fishing activity, represent certain difficulties to the collection of observations in situ. Only a few current time series were obtained on the slope; those obtained on the shelf only cover the summer period. Models help explain the general circulation dynamics. Observational programs carried out in the forthcoming years will probably provide more definitive results on the Gulf of Lions' hydrodynamics. (Author's abstract)
W91-05452

CAESIUM DISTRIBUTION IN NORTHWEST MEDITERRANEAN SEAWATER, SUSPENDED PARTICLES AND SEDIMENTS.
Commissariat a l'Energie Atomique, La Seyne-sur-mer (France).
For primary bibliographic entry see Field 5B.
W91-05453

HYDROGRAPHIC STRUCTURE AND NEPHELOID SPATIAL DISTRIBUTION IN THE GULF OF LIONS CONTINENTAL MARGIN.
Neuchatel Univ. (Switzerland). Groupe Oceane.
For primary bibliographic entry see Field 2J.
W91-05454

NUTRIENTS AND PHYTOPLANKTON IN THE GULF OF LIONS, NORTHWESTERN MEDITERRANEAN.
Consejo Superior de Investigaciones Cientificas, Gerona (Spain). Centro de Estudios Avanzados de Blanes.
For primary bibliographic entry see Field 2H.
W91-05455

210-PO, 210-PB IN SEDIMENT TRAP PARTICLES ON A MEDITERRANEAN CONTINENTAL MARGIN.
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 2J.
W91-05456

FLUX OF TRANSURANIUM NUCLIDES AND CHLORINATED HYDROCARBONS IN THE NORTHWESTERN MEDITERRANEAN.
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
For primary bibliographic entry see Field 5B.
W91-05457

CONTRIBUTION OF THE RHONE RIVER TO ORGANIC CARBON INPUTS TO THE NORTHWESTERN MEDITERRANEAN SEA.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
For primary bibliographic entry see Field 2J.
W91-05458

TRACERS AND CONSTITUENTS INDICATING THE NATURE OF ORGANIC FLUXES, THEIR ORIGIN AND THE EFFECT OF ENVIRONMENTAL CONDITIONS.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
F. Gadel, A. Puigbo, J. M. Alcaniz, B. Charriere, and L. Serve.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 1039-1062, 1990. 3 fig, 8 tab, 55 ref.

Descriptors: *Environmental impact, *Environmental tracers, *Gulf of Lions, *Mediterranean Sea, *Organic matter, *Path of pollutants, *Rhone River, *Suspended sediments, Algal physiology, Carbohydrates, Coastal waters, Deltas, Gas chromatography, Particulate matter, Phenols, Phytoplankton, Prodeltas, Sediment sampler, Sedimentation, Spectrometry, Stream discharge.

The nature of particulate organic matter was studied in suspended material sampled by bottles, particles collected by sediment from the northwestern Mediterranean in the Gulf of Lions. Elemental analyses were combined with pyrolysis-gas chromatography-mass spectrometry and with analysis of individual compounds such as phenols separated by high performance liquid chromatography. In the Rhone delta, the surficial turbid layer was enriched with fresh material of river origin. The river regime determined the nature and quantity of suspended material. When the water level was low, organic matter seemed to be of local origin, and the content of phenols and nitrogen-containing compounds increased. The influence of the Rhone River decreased off the mouth, when terrestrial markers were diluted by products derived from phytoplanktonic activity. In the southwestern part

of the Gulf of Lions, organic matter from sediment traps was fresher than in the Rhone delta. Phenols and some carbohydrates rapidly decreased from the prodelta due to a lower runoff. During the spate, suspended material was rapidly deposited and sediments were enriched in terrestrial phenols. In the open sea environment, in the Lacaze-Duthiers Canyon at 645 m, in summer, the euphotic zone was rich in amino-sugars and contained a high diversity of phenols derived from fish fecal pellets. In winter and spring, the development of phytoplanktonic blooms in surficial layers led to high contents of nitrogenous compounds. In deeper layers, the nature of organic matter was different from surficial layers in summer and more homogeneous in winter, although a flux of degraded material rich in pyrolysis-derived aromatic hydrocarbons and poor in nitrogenous compounds progressively sank towards the bottom. Organic matter was more degraded in suspended material, while in the southwestern part of the Gulf of Lions, the prodelta reflected the influence of local rivers, with lower discharges. (Author's abstract)
W91-05459

SEASONAL CHANGES IN STANDING CROP OF ZOSTERA MUELLERI IN SOUTH-EASTERN AUSTRALIA.
Deakin Univ., Melbourne (Australia). Div. of Biological and Sciences.
E. A. Kerr, and S. Strother.
Aquatic Botany AQBODS, Vol. 38, No. 4, p 369-376, December 1990. 3 fig, 2 tab, 29 ref.

Descriptors: *Aquatic plants, *Australia, *Estuaries, *Estuarine environment, *Sea grasses, Biomass, Leaves, Light effects, Plant growth, Plant tissues, Rhizomes, Roots, Seasonal variation, Statistical analysis, Temperature effects.

The sea grass Zostera muelleri Irmisch ex Aschers. is a significant primary producer in shallow embayments and estuaries of southeastern Australia. Seasonal influence on its growth is therefore of ecological importance. Estimates of above-ground (leaves, sheaths) and below-ground (roots, rhizomes) biomass were determined for Z. muelleri over a period of 18 months in order to study seasonal changes. Two separate sampling areas were chosen within Swan Bay, Victoria. The sites were chosen because of their differing characteristics and their accessibility. A 0.02 sq.m. sampler was used and the samples were washed through a 3-mm mesh sieve. The washed material was sorted into below-ground and above-ground parts. If flowers were present, the flowering shoots were separated and weighed separately. Samples were oven dried to constant weight. Spearman rank correlation coefficients were used to determine the association between above-ground biomass and a number of environmental variables. A winter dieback was evident with the maximum difference between winter and summer above-ground biomass being seven-fold at Tip Island and 40-fold at Swan Bay Jetty. Although above-ground biomass was correlated with solar radiation, day length and maximum temperature, it was concluded that leaf growth is still a better correlate of seasonal change than biomass for Z. muelleri growing in southeastern Australia. (Agostine-PTT)
W91-05488

CHARACTERISTICS OF A MARSHLAND SOIL BUILT UP FROM MARINE AND PEAT MATERIAL.
Oldenburg Univ. (Germany, F.R.). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-05568

FATE OF MANGROVE LITTER IN A MANGROVE FOREST ON KO YAO YAI, SOUTHERN THAILAND.
Phuket Marine Biological Center (Thailand).
H. Chansang, and S. Poovachiranon.
Phuket Marine Biological Center Research Bulletin, No. 54, p 33-46, 1990. 5 fig, 3 tab, 29 ref.

Descriptors: *Estuaries, *Litter, *Mangrove swamps, *Thailand, Andaman Sea, Climatic effects, Detritus, Field tests, Seasonal variation, Swamps, Tidal effects, Tides.

It is generally accepted that there are several factors which control mangrove productivity and the contribution to their estuaries. Andaman sea. Leaf fall, litter decomposition and accumulation within the forest, and export were studied for a 2-month period in a mangrove forest at Yao Yai Island in the Andaman Sea. There are two dominant seasons, a rainy season when the Southwest Monsoon predominates and a dry season when the Northeast Monsoon prevails. Litter traps were hung beneath trees at a height of 1.3 m above the ground at test sites. Ground litter samples were collected from areas first cleared of litter. For the litter export study floating material was collected using a mesh size 1.2 cm placed across 1/3 of the width of the main channel entrance. Surface water samples were taken at intervals during neap and spring tides for suspended particulate matter. The frequency of tidal inundation was found to play a significant role in the process of decomposition and accumulation at various localities within the forest. Export of litter and suspended particles were studied over complete cycles at spring and neap tides. Most of the export occurred during ebbing spring tides. Tides are thus an important factor controlling the fate of mangrove litter within the forest, and in terms of exporting mangrove production into the coastal waters of the Andaman Sea. (Agostine-PTT)
W91-05574

INVESTIGATION OF HYDROGEN PEROXIDE CHEMISTRY IN SURFACE WATERS OF VINEYARD SOUND WITH H2-18O2 AND 18O2.
Woods Hole Oceanographic Institution, MA. Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W91-05577

PHOSPHATE UPTAKE ALONG A COASTAL PLAIN ESTUARY.
Delaware Univ., Lewes. Coll. of Marine Studies.
For primary bibliographic entry see Field 5B.
W91-05580

STABLE CARBON ISOTOPES AND THE C:N RATIO IN THE ESTUARIES OF THE PAMLICO AND NEUSE RIVERS, NORTH CAROLINA.
East Carolina Univ., Greenville, NC. Dept. of Biology.
E. A. Matson, and M. M. Brinson.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1290-1300, September 1990. 6 fig, 3 tab, 33 ref.

Descriptors: *Carbon cycle, *Carbon radioisotopes, *Estuaries, *Isotope ratios, *Neuse River, *North Carolina, *Nutrients, *Pamlico River, *Tracers, Atmospheric chemistry, Carbon dioxide, Freshwater, Particulate matter, Phytoplankton productivity, Runoff, Salinity, Sediment chemistry.

The C:N and stable C isotope ratios (delta 13C) of sedimentary and seston organic C (OC) were used to identify OC sources and sites of deposition in two large estuaries in North Carolina. In the upper 10 km of the oligohaline zones, C:N ratios of sediment are characteristic of particulate terrestrial plant material (>15). The delta 13C values increase linearly with distance from freshwater tributaries to the mouths of the estuaries (approximately 20% salinity), >40 km from the ocean. Observed gradients in isotopic and C:N ratios imply that conservative mixing of freshwater and marine OC occurs. Phytoplankton in the estuaries produce at least 10 times more particulate OC than is delivered in runoff, however, and its biomass is recycled at rates much faster than those of water exchange. The observed gradients are therefore largely attributed to recycling of a resident pool of estuarine C, atmospheric CO2, and an increasing marine bicarbonate fraction from the salt wedge downriver. Essentially lentic conditions in these estuaries ensure the dominance of in situ biological processes. (Author's abstract)
W91-05581

MASS FLUX ESTIMATION AND MASS TRANSPORT MECHANISM IN ESTUARIES.
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
J. K. Park, and A. James.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1301-1313, September 1990. 7 fig, 8 tab, 21 ref.

Descriptors: *Estuaries, *Mass transport, *Mathematical models, *Salinity, *Water circulation, Error analysis, Estimating, Fluctuations, Tidal variation.

Hydrodynamic surveys were conducted in a partially stratified estuary. Longitudinal salt fluxes through a cross-section were measured and the optimal number of lateral and vertical points for observation and estimation of fluxes of pollutants found. The hydrodynamic data were decomposed to investigate the mechanism of instantaneous and tidally averaged mass fluxes. The decomposition method developed showed that instantaneous salt flux arose principally from the combination of velocity fluctuation with the tidal mean salinity. The error analysis showed that the estimate of mass flux was sensitive to the error inherent in the velocity data and the error range was within +/- 10% of the total flux. Seven depth and four width points gave acceptable estimates of the water flux, salt flux, and longitudinal dispersion. (Author's abstract)
W91-05582

SUBSIDENCE, ACCRETION, AND SEA LEVEL RISE IN SOUTH SAN FRANCISCO BAY MARSHES.
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
W. H. Patrick, and R. D. DeLaune.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1389-1395, September 1990. 5 fig, 16 ref.

Descriptors: *Accretion, *Global warming, *Salt marshes, *San Francisco Bay, *Sea level, *Sediment transport, *Sedimentation, *Subsidence, Elevation, Marshes, Peat, Storms, Tidal effects.

Accelerated sea level rise that is predicted to occur as a result of the greenhouse effect is likely to have a significant effect on the world's salt marshes. For salt-marsh vegetation to remain productive and even to survive in a period of rising sea level, the marsh must accrete sufficient sediment to maintain the marsh surface within an appropriate tidal range. Accretion and subsidence were studied in three south San Francisco Bay salt marshes that differed greatly in subsidence over the past few decades. Marsh accretion as a result of sedimentation and peat formation has been able to compensate for high rates of subsidence and the low rate of sea level rise and to maintain the elevation of the marsh surface above mean high water. South San Francisco Bay appears to be a sediment-rich system that transports enough sediment by tidal action and during storm events to compensate for sea level rise and subsidence in the fringing salt marshes. (Author's abstract)
W91-05587

EVIDENCE AGAINST INCORPORATION OF EXOGENOUS THYMIDINE BY SULFATE-REDUCING BACTERIA.
Harvard School of Public Health, Boston, MA. Interdisciplinary Programs in Health.
C. C. Gilmour, M. E. Leavitt, and M. P. Shiaris.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1401-1409, September 1990. 1 fig, 3 tab, 28 ref. EPA Grants CR-812699 and R-812527-01-0.

Descriptors: *Bacterial physiology, *Chesapeake Bay, *Estuarine environment, *Estuarine sediments, *Sulfur bacteria, Amino acids, Anoxia, Bacterial growth, Desulfovibrio, Estuaries, Laboratory methods, Marine environment, Metabolism, Reduction, Sediment chemistry, Sulfates.

The uptake of exogenous tritiated thymidine by SO4(2-)reducing bacteria (SRB) was tested in both pure culture and in marine sediments. Ten cultures

isolated from mesohaline sediments of Chesapeake Bay, plus ATCC strain Desulfovibrio desulfuricans aestuarii, were incubated in SO4(2-)-reducing media with tritiated TdR concentrations ranging from 2 to 100 nM. In most cases tritiated TdR uptake levels were no more than a few times higher than Formalin-killed controls; SRB cells took up a maximum of 1.7 to the minus 22nd power moles TdR/cell/hr. Across all incubations, an average of 3.3 to the 23rd power SRB cells were produced/(mol tritiated TdR) taken up, compared to an average value of approximately 2 to the 18th power cells/(mol tritiated TdR) in natural, oxic waters. In anoxic sediments the addition of molybdate, an inhibitor of SO4(2-) reduction, significantly reduced amino acid metabolism but did not decrease tritiated TdR incorporation into TCA-insoluble material. These data suggest that the thymidine uptake method may drastically underestimate bacterial production in samples where SO4(2-) reduction is quantitatively important, such as nonsurficial marine and estuarine sediments and anoxic saline waters. (Author's abstract)
W91-05588

EXCRETION OF ORGANIC CARBON BY PHYTOPLANKTON: ITS RELATION TO ALGAL BIOMASS, PRIMARY PRODUCTIVITY AND BACTERIAL SECONDARY PRODUCTIVITY IN THE BALTIC SEA.
Tvarminne Zoological Station (Finland).
For primary bibliographic entry see Field 2H.
W91-05590

SEASONAL CONTRASTS IN DIURNAL CARBON INCORPORATION BY PHYTOPLANKTON SIZE CLASSES OF THE COASTAL PLUME OF CHESAPEAKE BAY.
Salisbury State Univ., MD. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W91-05591

TEMPORAL DISTRIBUTION OF ICHTHYOPLANKTON NEAR BEAUFORT INLET, NORTH CAROLINA.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
W. F. Hettler, and A. J. Chester.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 157-168, December 15, 1990. 9 fig, 2 tab, 25 ref.

Descriptors: *Estuarine fisheries, *Fish larvae, *Marine environment, *North Carolina, *Temporal distribution, Fish behavior, Population density, Salt marshes, Seasonal variation, Species composition.

Temporal distribution of the larval/early juvenile fish community of a major inlet on the North Carolina coast was studied from August, 1986 through July, 1987 using bow-mounted pushnets. Three main seasonal assemblages were observed, winter/early spring, late spring, and summer. Peak abundance occurred in late spring; few fishes were caught in November. Cold-water (<20 C) species were primarily late post-flexion and transforming larvae, whereas many of the warm water species were pre-flexion or flexion stage larvae (indicating near-by, possibly estuarine, spawning). Families with the most species were Bothidae, Gobiidae, and Sciaenidae. A total of 74 species or species groups were collected. Engraulidae made up 70% of the total catch out of the 34 families collected. High variability was noted between samples within collections. One-third of the species collected were found to invade adjacent salt marsh habitat as juveniles. (Author's abstract)
W91-05593

POPULATION GROWTH AND EFFECTS OF NEMATODES ON NUTRIENT REGENERATION AND BACTERIA ASSOCIATED WITH MANGROVE DETRITUS FROM NORTHEASTERN QUEENSLAND (AUSTRALIA).
City Coll., New York. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W91-05594

EFFECTS OF ESTUARINE ENVIRONMENTAL CONDITIONS ON POPULATION DYNAMICS OF YOUNG-OF-THE-YEAR GULF MENHADEN.
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
L. A. Deegan.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 195-205, December 15, 1990. 8 fig, 4 tab, 45 ref.

Descriptors: *Estuaries, *Estuarine fisheries, *Fish larvae, *Louisiana, *Marine environment, *Menhaden, *Population dynamics, Abundance, Aquatic habitats, Bays, Fish growth, Fish migration, Marshes, Mortality, Productivity, Seasonal distribution, Temperature effects.

Environmental factors, primarily river discharge and winter temperatures, are strongly correlated with growth and survival of young-of-the-year gulf menhaden Brevoortia patronus in Fourleague Bay, Louisiana. Gulf menhaden were found in highest abundance from February to November. They first use marsh creeks and then in early summer they migrate out into deeper open bay areas where they remain until late summer or fall. This migration pattern coincides with the productivity peaks in marsh and open bay areas. Instantaneous growth coefficients were slightly different between years (1982 = 0.005, 1983 = 0.004). Mortality rates were different between year-classes (1982 year-class = 0.007; 1983 year-class =0.018), but not between habitats within a year-class. In periods of high river discharge and cooler spring temperatures, fish apparently grew more slowly and mortality rates were higher. (Author's abstract)
W91-05595

TIDAL HYDRAULICS OF SAINT JOHN RIVER.
Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (Mexico).
G. Godin.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 1, p 19-28, 1991. 3 fig, 3 tab, 9 ref.

Descriptors: *Estuaries, *New Brunswick, *Saline-freshwater interfaces, *Tidal energy, *Tidal hydraulics, *Tidal rivers, Canada, Flow discharge, Runoff, Spring tides, Tidal range, Water level fluctuations.

The Reversing Falls separate the Saint John River in New Brunswick, Canada, almost completely from its tidal estuary. Therefore only a small portion of the energy present in the Bay of Fundy tide manages to reach the estuary. Harmonic analyses reveal that 28-day and 15-day oscillations, not the semidiurnal tide, dominate the fluctuations in the water levels upstream although the latter is unusually strong in the estuary. The long-period oscillations are created by the periodic retention of some of the freshwater during intervals of perigean or spring tides, the cause of the phenomenon being obvious during intervals of constant discharge. Wide fluctuations in runoff created by the spring freshet mask the interaction temporarily. Since the range of downstream tides still contributes to the retention of fresh water, the coincidence of a peak in runoff with extreme tidal ranges could create unusually high levels upstream. (Author's abstract)
W91-05783

WAVE FORCES ON A WALL.
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 8B.
W91-05785

ENVIRONMENTAL ASSESSMENT OF HUMAN INTERFERENCE ON THE NATURAL PROCESSES AFFECTING THE BARRIER BEACHES OF LONG ISLAND, NEW YORK.
Hofstra Univ., Hempstead, NY. Dept. of Geology.
For primary bibliographic entry see Field 4C.
W91-05797

HISTORY OF A CHLORPYRIFOS SPILL: CARTAGENA, COLOMBIA.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
For primary bibliographic entry see Field 5B.
W91-05901

GREENHOUSE EFFECT AND COASTAL WETLAND POLICY: HOW AMERICANS COULD ABANDON AN AREA THE SIZE OF MASSACHUSETTS AT MINIMUM COST.
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 2B.
W91-05905

RECOGNITION OF AREAS EFFECTED BY PETROLEUM SEEPAGE: NORTHERN GULF OF MEXICO CONTINENTAL SLOPE.
Texas A and M Univ., College Station. Geochemical and Environmental Research Group.
For primary bibliographic entry see Field 5B.
W91-05915

SEA FLOOR RESPONSES TO HYDROCARBON SEEPS, LOUISIANA CONTINENTAL SLOPE.
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.
For primary bibliographic entry see Field 5B.
W91-05916

GULF OF MEXICO HYDROCARBON SEEP COMMUNITIES: VI. PATTERNS IN COMMUNITY STRUCTURE AND HABITAT.
Texas A and M Univ., College Station. Geochemical and Environmental Research Group.
For primary bibliographic entry see Field 5B.
W91-05917

ASSESSMENT OF FUTURE COAST LAND LOSS ALONG THE UPPER TEXAS GULF COAST TO THE YEAR 2050.
Texas Univ. at Austin. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W91-05936

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

LIKELIHOOD OF SIGNIFICANT COST REDUCTIONS IN DESALINATION.
Ewbank Preece Consulting Ltd., Brighton (England).
N. M. Wade.
Desalination DSLNAH, Vol. 78, No. 2, p 147-156, August 1990. 3 fig, 2 tab.

Descriptors: *Potable water, *Water treatment, *Economic aspects, *Desalination, *Cost analysis, Energy costs, Operation cost, Brackish water, Wastewater treatment, Treatment techniques, Multistage flash, Multieffect distillation, Reverse osmosis, Electrodialysis.

Desalination costs had fallen considerably in real cost terms until recent material cost rises occurred. It seems unlikely that entirely new processes will take the place of existing techniques (multistage flash, multieffect distillation, reverse osmosis and electrodialysis) during the next few years. The emphasis for development is therefore on steady improvements in existing processes. Savings in capital costs by cheaper materials and mass production of components and in operation and energy costs can all contribute to progressive rather than dramatic fall in real costs. It is probably only in brackish water and effluent treatment that desalination can become competitive with conventional treatment techniques in cost terms.

Brackish water plant overall cost is about 1/3 that for seawater treatment while membrane technology can be applied to tertiary effluent treatment for the reuse of polluted river water or recovery of effluent. There could be considerable scope for such application in Third World as well as industrialized countries. (Medina-PTT)
W91-05193

MEMBRANE SOFTENING: THE CONCEPT AND ITS APPLICATION TO MUNICIPAL WATER SUPPLY.
Stone and Webster Water Technology Services, Fort Lauderdale, FL.
For primary bibliographic entry see Field 5F.
W91-05194

EXPERIMENTS ON SEA WATER DESALINATION BY MEMBRANE DISTILLATION.
Water Reuse Promotion Centre, Tokyo (Japan).
K. Ohta, K. Kikuchi, I. Hayano, T. Okabe, and T. Goto.
Desalination DSLNAH, Vol. 78, No. 2, p 177-185, August 1990. 13 fig, 1 tab.

Descriptors: *Membrane processes, *Membrane distillation, *Desalination, *Desalination apparatus, *Distillation, Flow rates, Water temperature, Brine, Cooling water, Diffusivity.

The effects of flow rate and temperature on permeate flux and thermal efficiency were studied using direct contact module with silicone membrane. Test modules were of the plate and frame type. When flow rates were changed from 1.9 to 3.3 cm/s, the permeate fluxes increased with increases in flow rate, under a condition of approximately equal flow rates of brine and cooling water. Greater fluxes with greater flow rates of brine at fixed temperature and flow rate for cooling temperatures of 25, 30, and 35 C were observed under conditions of variable brine flow and constant cooling flow and vice versa. Temperature was also an important factor that influenced operational conditions. The permeate flux was higher in lower cooling temperatures. Other forces such as larger diffusion velocity in membrane and lower water viscosity were shown to promote the permeate at higher pressure differences or higher temperature ranges. An increase in flow rate generally improved the thermal efficiency for each temperature setting at 40, 50 and 60 C, but the effect was not considerable. Thermal efficiency (ratio of effective heat to input heat except emanation) had a tendency to increase under conditions of higher permeate flux. This efficiency increased along with temperature differences, but is expressed by a line independent of flow rate. This means that efficiency was affected by temperature difference but little by the flow rate of brine. (Medina-PTT)
W91-05195

ECONOMICS OF DESALINATION FOR THREE PLANT SIZES.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Thermal Engineering.
A. A. Madani.
Desalination DSLNAH, Vol. 78, No. 2, p 187-200, August 1990. 2 fig, 6 tab, 32 ref.

Descriptors: *Economic aspects, *Desalination, *Desalination plants, *Cost analysis, Solar stills, Reverse osmosis, Air dehumidification, Direct contact freezing process, Vapor compression distillation, Butane freezing process, Reverse osmosis, Multi effect evaporation, Multi stage flash, Flash distillation.

The economics of three desalination plant sizes, namely small plants with a capacity less than 100 cu m/d, medium plants with a capacity between 100 and 200 cu m/d, and large plants with a capacity greater than 200 cu m/d, were compared. For small-size plants, solar stills, solar assisted desalination, conventional reverse osmosis and the proposed process of dehumidification of air using sea water as a heat sink, were compared. For medium-size plants, the direct contact freezing process was compared with the most efficient process at this size, mechanical vapor compression (MVC). For large plants, the commercially undeveloped butane freezing process was considered as an economical alternative to the distillation process and reverse osmosis plants. For commercially available desalination processes, the solar stills and solar-assisted multi-effect evaporation processes were the best choice for small scale plants when the land value was low. Reverse osmosis was the best choice when land value was significant and skilled labor was available. For medium-sized plants, MVC the most economical. For large plants, the dual purpose distillation methods (multi effect evaporation and multi-stage flash) were the most economical. Saving in desalination cost could be achieved for medium-sized plants by developing the direct contact freezing process. Conservatively, the savings is about 15%. Developing the butane freezing process for large plants could reduce the desalination cost by over 30% for 10 mgd plants. More saving could be realized for larger plants. Dehumidification of air using water as a heat sink is a feasible process for producing small quantities (0.5-3 cu m/day) of fresh water at seaside locations when the land value is high and skilled plant operators are unavailable. (Medina-PTT)
W91-05196

EVALUATION OF OPTIMUM THICKNESS OF BOTTOM INSULATION FOR A CONVENTIONAL SOLAR STILL.
Indian Inst. of Tech., New Delhi. Centre of Energy Studies.
N. K. Dhiman.
Desalination DSLNAH, Vol. 78, No. 2, p 201-208, August 1990. 8 fig, 2 tab, 1 ref.

Descriptors: *Distillation, *Model studies, *Desalination, Economic aspects, *India, *Mathematical models, *Solar stills, *Insulation, Solar distillation, Climates, Cost analysis.

A mathematical analysis is presented for evaluating the optimum thickness of insulation required at the bottom of a conventional basin-type solar still corresponding to the minimum cost of distillate yield. The usefulness of analysis was illustrated by evaluating optimum thickness of insulation for the four typical climates of India namely New Delhi, Bangalore, Jodhpur and Srinagar. Inflation rate, annual interest rate, total cost and lifetime of a solar still and minimum cost of corresponding optimum insulation thickness for these areas were taken into consideration. There was a fall in the annual cost of the still per unit of yield corresponding to the optimum thickness of the insulation with increase in the inflation rate, whereas an increase in annual rate of interest, total cost and rate of maintenance increased this annual cost. Annual cost for Srinagar was higher than the other three places which is expected because of its high altitude. The calculations also showed that there was no significant effect of the lifespan of the still and cost of insulation over this annual cost of the still per unit of the yield. (Medina-PTT)
W91-05197

3B. Water Yield Improvement

SECOND ISRAELI RAINFALL STIMULATION EXPERIMENT: ANALYSIS OF PRECIPITATION ON BOTH TARGETS.
Rochester Univ., NY.
K. R. Gabriel, and D. Rosenfeld.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 10, p 1055-1067, October 1990. 2 fig, 18 tab, 16 ref, 5 append. NSF Grant ATM-8610028.

Descriptors: *Cloud seeding, *Israel, *Statistical analysis, *Weather modification, Artificial precipitation, Clouds, Deserts, Ice.

The second Israeli randomized rainfall augmentation experiment (Israel II) was carried out during the six winters from 1969/70 to 1974/75. Each day, was randomly allocated to be seeding either in the north or the south. However, seeding was actually carried out only when suitable clouds were found. A control area upwind of the target was chosen. Results from the experiment for both alternative targets show that apparently significant positive seeding effects in the north were accompanied by equally strong apparently negative effects in the south. Various statistical breakdowns of the data were tried, but they did not allow an unequivocal conclusion as to whether (1) there were real and opposite effects in the two areas; or (2) the apparent negative effect was a chance occurrence, or (3) both apparent effects were due to chance. Comparison with the Israel I experiment offers the explanation that in many rain situations there are sufficient natural ice nuclei in the south, because that area borders on the desert and desert dust has been proven to produce large quantities of ice nuclei, which interfere with seeding. (Fish-PTT)
W91-05856

3C. Use Of Water Of Impaired Quality

DEGRADATION OF CHERNOZEMS ON THE DANUBE-DNIESTER IRRIGATION SYSTEM.
Odessa Agricultural Inst. (USSR).
N. A. Kreyda, V. I. Mikhayluk, and I. D. Kichuk.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 81-86, 1990. 5 tab, 3 fig.

Descriptors: *Water pollution effects, *Danube River Basin, *Irrigation effects, Agricultural practices, *Chernozems, Soil physical properties, *Soil chemistry, Cation exchange, Alkalinity, Hydrogen ion concentration, Acidification, Water quality, Soil profile.

Data are presented on changes in the morphology, and physical and physicochemical properties (sodium and lime potential, and composition of adsorbed cations) of Chernozems on the southern Danube-Dniester irrigation system. These soils have low sodium activities and an elevated alkalinity (pH approximately 7.6 to 8.0). Irrigation of Chernozems even using water with a low mineral content disturbs their thermodynamic equilibrium. Three years of study showed that acidification of irrigation water, gypsuming of the soils, and application of manure, as well as different tillage practices had no significant meliorative effect on the Chernozems irrigated with Sasyk water. Results suggest that only a fundamental improvement of water quality will prevent the current degradation of irrigated Chernozems, the upper part of the profile of which is becoming compact and solonetzic. (Brunone-PTT)
W91-05227

LABORATORY STUDY ON LEACHING OF CALCAREOUS SOIL FROM KUWAIT.
Kuwait Univ., Safat. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-05378

INTERNATIONAL PERSPECTIVE ON WATER RESOURCES MANAGEMENT AND WASTEWATER REUSE--APPROPRIATE TECHNOLOGIES.
International Bank for Reconstruction and Development, Washington, DC. Infrastructure and Urban Development Dept.
C. R. Bartone.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2039-2047, 1991. 1 tab, 24 ref. UNDP/World Bank Integrated Resource Recovery Project INT/87/035.

Descriptors: *Arid lands, *Developing countries, *Reclaimed water, *Semiarid lands, *Water resources management, *Water reuse, Aquaculture, Disinfection, Irrigation water, Public health, Public policy, Wastewater renovation, Wastewater utilization.

The unabated urbanization and industrialization process in many arid and semi-arid countries leads to increasing demand for municipal and industrial water supply, often in direct competition with irrigation demand. In such cases wastewater reclamation and reuse should be an integral component of water resources management strategies. Nation-

al reuse policies should be developed and implemented taking into account local conditions and based on affordable approaches that ensure safe reuse practice. Research and development is being carried out in several developing countries on appropriate technologies for implementing reuse, as well as coordinated international efforts to provide recommended guidelines and policies for safe wastewater reuse in agriculture and aquaculture. Wastewater is used for fishculture in India, Germany, Hungary, and a number of other countries. Most existing reuse systems use raw or partially treated wastewater. One of the first initiatives for establishing public health guidelines was begun in 1982. A study concluded that wastewater treatment processes that effectively remove all or most of the pathogens in wastewater provide a major or total reduction in the negative health effects caused by raw sewage reuse. Recommended criteria for effective wastewater treatment for irrigation reuse in developing countries include maximum removal of helminths, effective reduction of bacterial and viral pathogens, and freedom from odor and appearance nuisances. Where overseason storage of effluents is needed, anaerobic treatment ponds followed by a deep reservoir system with long detention times is practical. In some instances soil-aquifer treatment system may be appropriate. Aerated ponds and anaerobic treatment process both offer reduced treatment costs and small land requirements. Pond effluents, because of their algal biomass content, have high fertilizer value and the algae act as a slow-release fertilizer. Although wastewater reclamation and reuse is becoming increasingly important in arid and semi-arid developing countries, it is necessary to consider it within an overall water resource development and management framework if reuse projects are to succeed. (Mertz-PTT)
W91-05532

ROLE OF WASTEWATER RECLAMATION AND REUSE IN THE USA.
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05533

RECENT ADVANCES IN WATER REUSE RESEARCH IN SOUTH AFRICA.
Water Research Commission, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W91-05534

ROLE OF WASTEWATER REUSE IN WATER RESOURCES MANAGEMENT IN ISRAEL.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
G. Shelef.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2081-2089, 1991. 5 fig, 5 tab, 16 ref.

Descriptors: *Israel, *Reclaimed water, *Wastewater utilization, *Water resources management, *Water reuse, *Water use, Activated sludge, Denitrification, Disinfection, Irrigation water, Nitrification, Stabilization ponds, Wastewater treatment, Water supply.

Wastewater reuse is considered as a major vital water resource in Israel with an annual flow of 420 million cubic m planned for the year 2010, constituting 19% of the total water supply and about one-third of the overall water allocated to the agricultural sector. The trend is for less crop restriction and wider crop rotation and thus higher effluent quality requirements. The economical considerations are favorable even with the need for seasonal storage and extra treatment. The best and largest example of seasonal storage of wastewater to be reused is the Greater Haifa-Tishlovet Hakishon scheme where over 15 million cubic m per year of biologically treated effluent is conveyed by a 30 km long pipeline to dual stabilization reservoirs. The points of disinfection along the scheme produce waters that almost meet Group D requirements (unrestricted use on crops, including raw vegetables and use in parks and on lawns). Seasonal and multi-yearly storage is accomplished in the Dan Region (Greater Tel-Aviv) wastewater reuse scheme that is the largest in Israel, with an annual flow of 80 million cubic m. Three-quarters of the wastewater is treated by a modern single-stage nitrification-denitrification activated sludge system and about one-quarter by a series of stabilization ponds with internal recirculation followed by lime-magnesia clarification and open-pond ammonia stripping. Final effluent is recharged into a sandy aquifer with storage retention of at least 300 days. Pipelines serve scores of agricultural communities at distances up to 80 km, where it is the major source of irrigation. (Mertz-PTT)
W91-05536

ASSESSING POTENTIAL HEALTH RISKS FROM VIRUSES AND PARASITES IN RECLAIMED WATER IN ARIZONA AND FLORIDA, USA.
University of South Florida, Tampa. Dept. of Environmental and Occupational Health.
For primary bibliographic entry see Field 5D.
W91-05537

GROUND WATER RECHARGE WITH SEWAGE EFFLUENT.
Agricultural Research Service, Phoeniz, AZ. Western Cotton Research Lab.
H. Bouwer.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2099-2108, 1991. 4 fig, 20 ref.

Descriptors: *Groundwater recharge, *Reclaimed water, *Wastewater disposal, *Water reuse, Coliforms, Filters, Nitrogen, Organic carbon, Sand filters, Soil filters, Viruses, Wastewater treatment, Wastewater utilization, Water quality standards.

Sewage effluent is an excellent source of water for irrigation, especially in dry areas. Before it can be used for unrestricted irrigation, conventional treatment should be followed by further treatment so that the water meets the agronomic, public health, and aesthetic requirements for unrestricted irrigation. This usually means reduction of nitrogen concentration to less than 10 mg/L, complete removal of pathogenic organisms, and essentially complete removal of suspended solids and biodegradable organic carbon. This can often be achieved with a groundwater recharge system, using the soil and aquifer materials as natural filters. Studies on two experimental projects in Phoenix showed that soil-aquifer treatment systems can reduce nitrogen concentrations from about 20 mg/L to about 7 mg/L, fecal coliform concentrations from about 3500/100 ml (chlorinated secondary effluent) to 0.3/100 ml, viruses from 21 plaque-forming units/L to 0, suspended solids from 15 mg/L to 1 mg/L, and total organic carbon from 20 mg/L to 3 mg/L. That organic carbon represents mostly the nondegradable carbon. Hydraulic loading rates for sands to loamy sands were about 300 feet/year. Thus 1 acre of infiltration basin can renovate about 300 acre feet/year of sewage effluent. The renovated water should be removed from the aquifer to avoid its spread into high-quality native groundwater. (Author's abstract)
W91-05538

USE OF RECLAIMED WASTEWATER FOR ORNAMENTAL AND RECREATIONAL PURPOSES.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
S. Ohgaki, and K. Sato.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2109-2117, 1991. 3 fig, 5 tab, 11 ref.

Descriptors: *Japan, *Reclaimed water, *Recreation, *Scenery, *Wastewater utilization, *Water reuse, Biological oxygen demand, Coliforms, Color, Hydrogen ion concentration, Irrigation water, Odors, Turbidity, Water quality standards.

Although Japan is not an arid area, water for a clean environment in the heavily urbanized areas is a scarce and precious resource. Several projects involving ornamental and recreational reuse employing reclaimed wastewater have been practiced in Japan. The wastewater reuse strictly for ornamental purposes holds a unique position in water reuse techniques. A guideline manual for ornamental and recreational reuse has been adopted by the Ministry of Construction in Japan. When setting water quality guidelines, hygienic safety and sensuous satisfaction were considered important aspects for reclaimed water to be used for ornamental and recreational purposes. Total coliforms is used as the hygienic index, biological oxygen demand and pH are considered environmental indices, and turbidity, odor, an color are aesthetic indices. The Tokyo Metropolitan Government started in 1974 to study the feasibility of restoring the Nobidome and Tamagawajousui channels to a pleasing ornamental watercourse environment. Tamagawajousui had lost its flow due to a water purification plant and Nobidome was receiving wastewater discharges. The restoring live stream project for Nobidome and Tamagawajousui channels has been accepted by the public. The geographical and historical background and the scarcity of flowing water in densely inhabited districts helped garner public support, although the wastewater reuse for ornamental purposes requires advanced techniques at a considerable cost for construction, operation and management. (Mertz-PTT)
W91-05539

EFFLUENTS QUALITY ALONG A MULTIPLE-STAGE WASTEWATER RECLAMATION SYSTEM FOR AGRICULTURAL REUSE.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
Y. Azov, and G. Shelef.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2119-2126, 1991. 5 fig, 1 tab, 3 ref.

Descriptors: *Agricultural water, *Irrigation water, *Israel, *Reclaimed water, *Water quality management, *Water reuse, Chlorination, Reservoirs, Stabilization ponds, Wastewater treatment, Wastewater utilization, Water quality, Water quality control.

A multiple stage wastewater reclamation system in northern Israel was analyzed for effluents quality along its components. Secondary effluents of Haifa's wastewater treatment plant are transferred to a small regulation reservoir, after which they are chlorinated either by chlorine gas during the day or by sodium hypochlorite during the night. The chlorinated wastewater travels along a 29 km long pipe to the stabilization reservoir. Upon leaving the stabilization reservoir the effluents are chlorinated for the second time with sodium hypochlorite. Effluents then flow by gravity to the operational reservoir. This is the central reservoir for the valley of Jezreel. The reclamation system used Haifa's treated wastewater to irrigate cotton fields and other crops in the Valley of Jezreel. During five years of operation it was found that each stage of the reclamation system, after the treatment plant, has some impact over effluents quality. Degradation of organic matter and bacterial regrowth take place at the effluents conduit that connects the treatment plant and the irrigated area along 30 km. This is mainly due to relatively long retention time of the effluents within the conduit because of operational restrictions. The stabilization reservoir that stores effluents during winter time, improves their quality to a great extent. The effluents that enter the operational reservoir at the irrigation season, are mixed with fresh water from the Sea of Galilee, and may cause rapid growth of phytoplankton and zooplankton populations. The reclamation system successfully replaces large amounts of fresh water otherwise used for cotton irrigation. (Mertz-PTT)
W91-05540

WASTEWATER REUSE FOR IRRIGATION IN THE NEAR EAST REGION.
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
A. Arar.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2127-2134, 1991. 3 tab, 11 ref.

Descriptors: *Developing countries, *Irrigation water, *Middle East, *Public policy, *Wastewater irrigation, *Water reuse, Health policy, Jordan, Kuwait, Libya, Morocco, Reclaimed water, Saudi Arabia, Syria, United Arab Emirates, Wastewater treatment, Wastewater utilization, Water resources management, Yemen.

Limited water supplies available in many countries of the Near East have led to a growing interest in the rational use of this increasingly important resource. Because wastewater irrigation ensures the reuse of resources and achieves better treatment of wastewater, plans have recently been formulated for large-scale use of this non-conventional source of water. Consequently, in several countries of the Near East Region, wastewater reuse in agriculture is an accomplished and accepted fact, with a high degree of social and political commitment. Intensive and direct reuse is being practiced in Kuwait, Saudi Arabia, Libya, the United Arab Emirates and Tunisia. Direct, but unsupervised reuse is being practiced in Yemen Arab Republic, Morocco and Syria. All forms of wastewater reuse is practiced in Egypt. Indirect and direct restricted reuse is practiced in Jordan. However, given the health and environmental hazards associated with reuse of wastewater, the formalization of wastewater treatment and reuse in all countries is urgent. Furthermore, in most countries poor coordination among the different agencies concerned with water supply, wastewater treatment, irrigation, public health and the environment is a key constraint for further wastewater reuse. (Author's abstract)
W91-05541

WATER SAVING AND WASTEWATER REUSE AND RECYCLE IN CHINA.
Beijing Municipal Research Inst. of Environmental Protection (China).
For primary bibliographic entry see Field 5D.
W91-05542

WASTEWATER REUSE CASE STUDIES IN THE MIDDLE EAST.
Acer Consultants Ltd., London (England).
P. A. Banks.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2141-2148, 1991. 5 tab.

Descriptors: *Middle East, *Reclaimed water, *Wastewater utilization, *Water reuse, Case studies, Groundwater recharge, Irrigation water, Qatar, Saudi Arabia, United Arab Emirates, Wastewater facilities, Wastewater treatment, Water resources management.

Within the past few decades the accelerating demand on natural resources to provide water for urban use, and the associated cost of meeting that demand, has led to an increased interest in the reuse of wastewaters for municipal, industrial and groundwater recharge purposes. The oil economies of the Middle East have severely arid climates which means that vegetation of every sort, except highly adapted desert micro plants, rely upon groundwater raised from underground aquifers or in recent times, desalinated seawater blended with groundwater. In some projects in the Middle East the potential for effluent use has been recognized at an early stage and sewage treatment facilities developed accordingly. Particular emphasis has been placed on operation and maintenance capabilities, availability of chemicals and spare parts, process reliability, capital and revenue funding and land areas required. Case studies portray reclamation installations in Abu Dhabi and Dubai in the United Arab Emirates, Doha in the State of Qatar and Taif in Saudi Arabia. Similar installations exist in Kuwait and other parts of Saudi Arabia and Israel. The practice of wastewater reuse in arid areas of the Middle East is well established and successful. From this success further and different uses could be found for this valuable resource, such as industrial or groundwater recharge. However, the use for amenity and agricultural irrigation is in line with traditional features of the pastoral activities of these societies. As a result, very significant improvements in the local urban environment have been made and the feasibility of crop production using effluent tested and proven. Conventional methods of treatment and irrigation have sufficed to achieve this with minor problems being overcome without difficulty. (Mertz-PTT)
W91-05543

WASTEWATER DISPOSAL BY SUB-SURFACE TRICKLE IRRIGATION.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
G. Oron, Y. DeMalach, Z. Hoffman, Y. Keren, and H. Hartman.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2149-2158, 1991. 1 fig, 6 tab, 14 ref.

Descriptors: *Irrigation water, *Subsurface irrigation, *Trickle irrigation, *Wastewater disposal, *Wastewater utilization, *Water reuse, Corn, Furrow irrigation, Irrigation, Soil filtration, Sprinkler irrigation, Wastewater treatment.

The contradictory problem of water shortage and environmental control can be met by the use of treated wastewater for irrigation. Effluent can be applied by implementing several different methods, such as furrow irrigation, sprinkler and trickle irrigation. Effluent application via sub-surface trickle irrigation simultaneously serves a dual function in the system: a trickling filter system to a limited depth, with the soil operating as the porous filter; and a disposal system for the effluent, which is used to maintain plant growth. Field experiments were conducted to evaluate the reuse of domestic, secondary treated wastewater for irrigation of edible crops. Corn was irrigated under on-surface and sub-surface trickle systems with effluent and compared with on-surface trickle irrigation applying fresh water. Drip technology for application of treated wastewater was found to be successful. No technical problems occurred in either the on-surface or sub-surface irrigation systems. For large-scale irrigation projects additional efforts for water filtration are recommended. To avoid disturbance, due to large-distance wind distribution of bacteria, the influence of adjacent wastewater irrigated fields should be evaluated. From the hygienic point of view, testing of the exclusive trickle irrigation seems reasonable for the cultivation of sweet corn. In order to reduce fecal contamination of sweet corn, the harvesting schedule should be delayed as long as possible after the last irrigation. In the future, other pollutants such as pesticides, solvents, and chlorinated hydrocarbons should also be considered. (Mertz-PTT)
W91-05544

TRENDS AND PROBLEMS OF WASTEWATER REUSE SYSTEMS IN BUILDINGS.
Tokyo Inst. of Tech. (Japan).
For primary bibliographic entry see Field 5D.
W91-05549

INVESTIGATION ON WASTEWATER REUSE ON PASSENGER AIRCRAFT.
Technische Univ. Hamburg-Harburg (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W91-05550

REUSE OF TREATED WASTEWATER IN AN ARTIFICIAL STREAM ('SESERAGI') IN KAWASAKI CITY, JAPAN.
Kawasaki City Sewage Bureau (Japan). Dept. of Planning.
For primary bibliographic entry see Field 5D.
W91-05551

ESTABLISHMENT AND PRODUCTION OF LUCERNE ON A SALINISED CLAY SOIL IRRIGATED WITH A MODERATELY SALINE GROUNDWATER.
Victoria Dept. of Agriculture and Rural Affairs, Tatura (Australia). Inst. for Irrigation and Salinity Research.
A. H. Mehanni, and P. Rengasamy.
Australian Journal of Experimental Agriculture AAAHAN, Vol. 30, No. 2, p 203-207, 1990. 4 tab, 15 ref.

Descriptors: *Agriculture, *Alfalfa, *Clays, *Groundwater, *Irrigation water, *Saline water irrigation, *Soil types, Aquifers, Australia, Conductivity, Crop damage, Electrolytes, Gypsum, Hydraulic conductivity, Nutrients, Physical properties, Saline soils, Sodium.

Groundwater with an average electrical conductivity of 3.8 dS/m, and a sodium adsorption ratio of 15.0, pumped from a shallow aquifer, was used to irrigate a lucerne crop established in a salinized clay soil after initial leaching of salts. Pumping and irrigation with groundwater reduced the topsoil salinity (average electrical conductivity of the saturation extract) from 22.1 to 5.9 dS/m in the first 15 months and the pasture progressively displaced the weeds. Lucerne, a moderately salt tolerant crop, was then established and grown for 4 consecutive years (1982-86). Irrigation treatments during this period were saline irrigation (control) and saline irrigation plus gypsum, applied either in irrigation water (4 m.e./L) or on the soil surface (10 and 20 t/ha). There were no significant differences in the dry matter production of lucerne between the control and gypsum treatments during the 3 years following the year of establishment. Mean yields over all treatments were 18143, 18375 and 16700 kg/ha. A decline in yield in 1985-86 was associated with leaf yellowing and brown necrosis and may have been caused by nutrient imbalance. Threshold concentrations of electrolytes were present in the soil whether gypsum was applied or not and, therefore, soil hydraulic conductivity was not affected by saline irrigation. This resulted in no beneficial effect of gypsum applied either in irrigation water or on the soil surface. (Author's abstract)
W91-05552

FIELD EVALUATION OF TISSUE CULTURE DERIVED SORGHUM FOR INCREASED TOLERANCE TO ACID SOILS AND DROUGHT STRESS.
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 2I.
W91-05558

MOVEMENT OF SALTS IN SOIL IRRIGATED WITH LOW AND HIGH CONDUCTIVITY WATERS.
Incitec Ltd., Morningside (Australia).
G. H. Price.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 13-16, p 1857-1877, 1990. 10 fig, 4 tab, 12 ref.

Descriptors: *Impaired water use, *Irrigation, *Path of pollutants, *Salts, *Soil chemistry, Agriculture, Australia, Conductivity, Drainage, Fertilizers, Ions, Seasonal variation, Semiarid lands, Tropic zone.

Growers from the agricultural region near Bowen in the Don River basin of coastal north Queensland, a region referred to as the dry tropics, rely on underground water for irrigating their crops during the dry season. The quality of this underground water varies greatly within the region and between seasons. Between the 1978/79 and 1987/88 summer seasons an unprecedented dry period was experienced, with the summer rainfall well below the long-term average of 878 mm. With no significant recharge of the aquifers, the quality of the irrigation water, as indicated by electrical conductivity (and other tests), declined substantially with some of the bore waters recording above 3 dS/M. Advisers in the area have been concerned about: (1) the effect of increasing soil salinity on crop growth and (2) the effect on crop growth of adding fertilizer to soils already containing reasonable concentrations of soluble salts. Experiments were conducted to assess changes in anion and cation concentrations in a black fine sandy clay loam soil treated with various fertilizer rate and furrow irrigated to compare the effects of high and low conductivity waters. The greatest concentration of salts was found in the top few centimeters of the beds, at the extremity of the wetting front. The results provide a basis for soil sampling guide-

lines, especially for troubleshooting, and when assessing the need for fertilizers for the next crop. In alluvial soils with restricted drainage, the soluble anions and cations can move laterally and longitudinally. They can change markedly in space and with time, depending on the soluble ion status of the irrigation water, the fertilizer product and rate used in previous and current crops. Soil sampling should be carried out in the mid-row at a depth of 0.05-0.08 m. (Agostine-PTT)
W91-05561

HYDRAULIC CONDUCTIVITY AND LEACHING OF AN ORGANIC SALINE-SODIC SOIL.
Agricultural Coll. of Athens (Greece). Lab. of Soils and Agricultural Chemistry.
For primary bibliographic entry see Field 2G.
W91-05565

GENERALIZED RESULTS FROM CROP YIELD MODEL WITH SALINE WATERS.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. W. Warrick.
Soil Science Society of America Journal SSSJD4, Vol. 53, No. 6, p 1641-1645, November/December 1989. 3 fig, 2 tab, 16 ref, append.

Descriptors: *Arid climates, *Crop yield, *Irrigation water, *Model studies, *Saline water, Mathematical models, Parameter estimation, Salinity, Seasonal distribution, Water quality.

Crop yields as influenced by water quality and quantity are of immense interest in arid areas throughout the world. Linear yield response functions are used for both the amount of water utilized and response to salts. The threshold for the salt response function is 3.9 d/m with a linear reduction resulting in no yield at 22.8 d/m. The necessary parameter values are average seasonally available water, CV of seasonally available water, the minimum water to obtain the maximum yield, threshold values for seasonally available water, salinity of water utilized, and salinity response. Results indicate that salinity is not a major factor, in that more variability of available water generally leads to lower average yields. This relatively simple approach is believed applicable to many practical scenarios for which a lack of input parameters or need for expediency rules out more comprehensive modeling. (Brunone-PTT)
W91-05601

EFFECT OF THE MELIORATIVE STATE OF IRRIGATED LANDS OF THE CHU RIVER VALLEY ON THE WATER-SALT REGIME AND YIELD.
All-Union Scientific Research Inst. of Fodder, Frunze (USSR). Agrometeorological Station.
For primary bibliographic entry see Field 3F.
W91-05826

3D. Conservation In Domestic and Municipal Use

WATER SUPPLY CHALLENGE IN THE GULF REGION.
Water Membrane Mfg. Co., Jeddah (Saudi Arabia).
A. D. Bushnak.
Desalination DSLNAH, Vol. 78, No. 2, p 133-145, August 1990. 4 fig, 3 tab, 4 ref.

Descriptors: *Governmental interrelations, *Regional development, Political aspects, *Gulf Cooperation Council, *Water demand, *Water shortage, *Potable water, *Water resources management, *Water policy, Water use efficiency, *Water conservation, Desalination, Water conveyance.

Water has a high strategic value for the countries of the Gulf Cooperation Council (GCC) because of its limited natural sources. This scarcity and the growing gap between demand and available supply of potable water in these areas constrains a challenge for wise policies and management programs to turn these challenges into opportunities. Maintaining economic prosperity with limited water supply, finding enough capital to increase supply, mastering advanced water technologies, securing supplies under all conditions, reducing negative impact to the environment, and coordinating the efforts of existing water institutions are some of the challenges facing the Gulf region. The key policies recommended include establishing regional water plans, reducing water subsidies, creating competition in water supply, increasing water supply options for both short and long terms, developing a local industrial base in desalination and other advanced water related technologies, and reducing the current waste in water use. Some specific programs to implement these policies include having government water organizations buy water through competitive market pricing, establishing a GCC fund for developing water technologies under the GCC General Secretariat, securing strategic water reserves, building a regional water pipeline network and making water conservation a duty for all users and sectors. (Author's abstract)
W91-05192

PORTLAND WATER DISTRICT'S WATER DISTRIBUTION MASTER PLAN.
Portland Water District, ME.
For primary bibliographic entry see Field 5F.
W91-05210

WHAT IS A WATER AUDIT.
Easton Water Div., MA.
W. P. Southworth.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 2, p 141-145, June 1990. 5 ref.

Descriptors: *Domestic water, *Municipal water, *Water loss, Water conveyance, *Massachusetts, *Water metering, *Water audit, *Leakage, Pumping plants, Hydrants, Calibrations, Grants.

In Massachusetts, the Division of Water Supply, Department of Environmental Protection has a standard water audit leak detection project workbook for those municipalities that have received state grants for leak detection surveys of drinking water distribution systems. The workbook includes tasks listing the system description; production and sales records on source meters; faulty operating functions; the review of billing and accounting procedures; adjustments for meter inaccuracies; review of meter reading records; current leak detection efforts; listing unmetered water uses; and a summary making recommendations for improvements and leak detection requirements. The experience of one superintendent's efforts to think about ways of providing better accountability for the water pumped into the system is presented. The most common and recurring elements from a number of models which he adopted in his system included replacement of meters more than 15 years old and equipped with remote reading devices, calibration of master meters at the pumping stations and institution of new hydrant maintenance programs. (Medina-PTT)
W91-05211

ALTERNATIVE WATER-DISTRICT ORGANIZATION: SCREENING-LEVEL ANALYSIS.
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 6B.
W91-05792

3E. Conservation In Industry

STUDY OF RECLAMATION OF SEWAGE FOR INDUSTRIAL WATERS.
National Univ. of Singapore. Dept. of Civil Engineering.
K. K. Chin, and S. L. Ong.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2181-2187, 1991. 6 tab, 5 ref.

Descriptors: *Industrial wastewater, *Industrial water, *Reclaimed water, *Wastewater treatment, *Water conservation, *Water reuse, Activated carbon, Chemical coagulation, Desalination, Reverse osmosis, Sand filtration, Singapore, Wastewater facilities, Water quality.

Reclamation of treated sewage for industrial uses has been in practice in Singapore since the 1960s. Over 90% of the Singapore Island of 2.5 million population is sewered. All sewage collected are treated using the conventional activated sludge processes. The Jurong Industrial Water Treatment Plant was built to upgrade the quality of the treated sewage. This plant has a capacity of 45,000 cubic m/day. The present demand for this water is 25,000 cubic m/day mainly for toilet flushing, floor cleaning and industrial cooling. Data of the performance of a 480 cubic m/day water reclamation plant to upgrade the Jurong Industrial Water Treatment Plant to ultra pure quality for cooling and for use as process water in the electronic industry is presented. The treatment train of this plant was sand filtration or carbon adsorption-0.45 micrometers cartridge filtration-reverse osmosis desalting-zeolite ion exchange deionization. The raw water used was reclaimed sewage that had been treated by the activated sludge system and polished by chemical coagulation and flocculation, multimedia sand filtration and chlorination. After the reverse osmosis step using the spiral wound cellulose acetate membrane most of the cations, anions and heavy metals present in the water were removed. Product water quality met with cooling water specifications but needed further improvement for the electronic industry. With proper choice of ion exchange resin and appropriate operating procedures the quality of the product water could be upgraded to meet with requirements of the electronic industry. (Mertz-PTT)
W91-05548

3F. Conservation In Agriculture

DYNAMIC RESPONSE OF AUTOMATIC WATER-LEVEL CONTROLLER: I. THEORY.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China).
C. Wang, A. J. Clemmens, and W. E. Hart.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 769-783, November/December 1990. 7 fig, 2 tab, 7 ref.

Descriptors: *Control systems, *Instrumentation, *Irrigation canals, *Measuring instruments, *Water level, Dual-acting controlled leak systems, Feedback control, Gates, Hydraulic engineering, Mathematical equations, Mathematical models.

Controllers that maintain constant water levels at various locations within irrigation canal distribution systems are used in a number of places. Most are custom-developed and tested on a particular system or are direct copies of earlier, successful versions. Design of such feedback-control mechanisms is hampered by a lack of information on the dynamic response of the control system to various conditions. The dynamic response of one type of system, the dual-acting controlled leak (DACL) system, was examined. Simple transfer-function equations were developed from which the stability and dynamic response of the system could be evaluated. The feedback-control model constructed took the form of a simple transfer-function block diagram. The model was second order. Hysteresis in the gate-float movement caused by gate friction was approximated with a linear relation. The canal response between the gate and control location was approximated by an exponential function because the pure delay of the travel time could not be modeled adequately. The remaining portions of the feedback-control system were modeled with coefficients based on some initial conditions. Thus, an individual response equation represents the slope of the system response at that given point. (See also W91-05132) (Rochester-PTT)
W91-05131

DYNAMIC RESPONSE OF AUTOMATIC WATER-LEVEL CONTROLLER: II. APPLICATION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.

A. J. Clemmens, C. Wang, and J. A. Replogle.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 784-796, November/December 1990. 2 fig, 7 tab, 7 ref.

Descriptors: *Control systems, *Instrumentation, *Irrigation canals, *Leakage, *Measuring instruments, *Water level, Dual-acting controlled leak systems, Feedback control, Gates, Hydraulic engineering, Mathematical equations, Mathematical models, Performance evaluation, Valves.

Simple transfer-function equations have been developed from which the stability and dynamic response of a dual-acting controlled leak (DACL) system for controlling the water level in canal networks could be evaluated. The feedback-control model constructed took the form of a simple transfer-function block diagram. Transfer-function equations were used to evaluate the stability and dynamic response of this system. The results showed that the system is always stable regardless of the physical dimensions chosen and that response time could be predicted adequately with the model. The control decrement was modeled adequately, but the control accuracy was not modeled well with the linear system used to approximate hysteresis in the gate-float movement. The control accuracy was predicted well by examining the hysteresis effects of the control valves. Using data reported previously, the model was tested for a system configured to maintain a constant discharge downstream from a radial take-off gate. The decrement in control for a change in upstream level was only 0.3%, whereas the settling time was roughly 10 min. For a change in control setting, the decrement was roughly 2.0% and the settling time was roughly 9.5 min. Gate friction and channel delays had an insignificant effect on control accuracy, but control valve friction proved to be the major contributor to the 6 to 7 mm control band. (See also W91-05131) (Rochester-PTT)
W91-05132

PERFORMANCE MEASURES FOR EVALUATION OF IRRIGATION-WATER-DELIVERY SYSTEMS.
Computer Assisted Development, Inc., Fort Collins, CO.
D. J. Molden, and T. K. Gates.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 804-823, November/December 1990. 8 fig, 4 tab, 16 ref.

Descriptors: *Irrigation canals, *Irrigation efficiency, *Irrigation engineering, *Performance evaluation, *Systems engineering, Egypt, Mathematical models, Network design, Spatial distribution, Sri Lanka, Temporal distribution.

Although various objectives for irrigation water delivery systems have been published, approaches to evaluation, planning, and design have seldom incorporated quantitative methods of system-performance evaluation that reflect those objectives. Performance measures were developed that facilitate analysis of irrigation-water delivery systems in terms of adequacy, efficiency, dependability, and equity of water delivery. The measures provide a quantitative assessment not only of overall system performance, but also of contributions to performance from the structural and management components of the system. Spatial and temporal distributions of required, scheduled, deliverable, and delivered water are used to calculate the performance measures. These variables may be estimated by a combination of field measurement and simulation techniques. The performance measures can be incorporated in an irrigation system monitoring program and can provide a framework for assessing system improvement alternatives. They are amenable to decomposition analysis of systems, allowing assessment of trends in performance among distinctly defined subregions or comparison of performance at different levels of system network hierarchy. Example applications to systems typical of Sri Lanka and Egypt have indicated the usefulness of the measures in system evaluation. (Author's abstract)
W91-05134

VAPOR-BUDGET MEASUREMENT OF IRRIGATION EVAPORATIVE LOSSES.
Clemson Univ., SC. Dept. of Civil Engineering.
P. Inmula, and B. L. Sill.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 824-836, November/December 1990. 5 fig, 3 tab, 6 ref.

Descriptors: *Evaporation, *Irrigation, *Vapor-budget technique, Boundary layers, Control systems, Field tests, Hydrologic budget, Water vapor, Wind velocity.

When the wind blows over an evaporating surface, a moisture boundary layer develops, with thickness increasing downwind. In a continuous process, moisture is put into the vapor layer by evaporation and subsequently carried horizontally by the wind. This layer is the focus of the vapor-budget method. A vapor-budget technique for measurement of short-term evaporation from moist, rough surfaces (such as irrigated cropped areas) was developed based on the control volume concept. The control volume is specified so that the difference in the horizontal fluxes of outgoing and incoming atmospheric water vapor equals the evaporation rate. The fluxes are estimated by measuring vertical profiles of wind speed and water vapor. A height of 3 m is sufficient for the present field application. Simplifications used in actual application of the technique were evaluated. The approach was field tested using a square test site, 30 m on each side, and the results were compared with simultaneous water-budget measurements of the evaporation. The vapor budget is within 12% of the water budget for steady wind direction so long as an average of five profile tests is used for each 15-min evaporation value. One of the primary advantages of the control volume approach is that it requires measurements only on the periphery, thus providing integrated evaporation values for complex surfaces. (Author's abstract)
W91-05135

SUBSTITUTING CLIMATE FOR GROUNDWATER IN AQUACULTURE: THE POTENTIAL FOR CONSERVATION IN THE SOUTHEASTERN UNITED STATES.
Mississippi State Univ., Mississippi State. Dept. of Agricultural and Biological Engineering.
C. L. Wax, and J. W. Pote.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 166-174, 4 fig, 19 ref.

Descriptors: *Aquaculture, *Groundwater management, *Mississippi, *Subhumid climates, *Water conservation, *Water resources management, Catfish ponds, Evaporation, Hydrologic budget, Infiltration rate, Precipitation, Water quality control.

In recent years, warm water aquaculture has expanded rapidly as an alternative crop in the southern region of the U.S, and the industry has experienced phenomenal growth in the last ten years, particularly in Mississippi, because of favorable temperatures and plentiful groundwater, the primary source of water for the industry. Recently, increased demand for groundwater and drought conditions have prompted growing concern over future availability and quality of this vital natural resource. A study was performed to evaluate groundwater conservation potential for warm water aquaculture in order to determine if the management scheme used in the Mississippi Delta is uniformly applicable throughout the entire region. Locations were chosen to evaluate the effectiveness of the scheme by taking into account the east-west precipitation gradient and the south-north change from maritime to continental characteristics. Climatological water budgets for ponds under differing climatic conditions were developed, for no-management, 'make-up' water (evaporation compensation), and the 6/3 scheme (allowing evaporation of 6 in., then adding only 3 in. to maintain storage capacity for captured rainfall). It was concluded that ponds with high infiltration rates should either be repaired or taken out of production. The practice of flushing to maintain water quality should be eliminated. While use of 'make-up' water is presently the best conservation practice employed, use of the suggested 6/3 scheme has the potential for drastically reducing groundwater use in aquaculture in the southern region. The potential average conservation of groundwater indicated by this study ranges from 65% to 82% and averages 76% regionally. (See also W91-05137) (Fish-PTT)
W91-05157

RICE AND FURROW IRRIGATION MANAGEMENT.
Soil Conservation Service, Greenwood, MS.
P. B. Rodrigue.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 178-185, 4 fig, 2 tab.

Descriptors: *Agricultural water, *Furrow irrigation, *Irrigation efficiency, *Irrigation management, *Mississippi, *Rice, Furrow drainage, Irrigation practices, Pipes, Runoff, Soil water, Water management.

Water use on rice fields has been monitored by the Soil Conservation Service (SCS) since 1987. Three rice fields were monitored during the summer of 1989 to determine how well water was managed on each. Furrow irrigation requires a high level of labor input to schedule and operate. Observations and measurement indicate that on most Mississippi Delta cotton land, intake rates decrease after an initial rate to a lower rate. Long opportunity (soak) times contribute more to runoff than soil moisture. It would appear advisable to use high furrow rates (15 gpm) for long (1320-ft) rows and lower rates (7 gpm) for shorter (800-ft) rows to push water to the end of the furrows, get a majority of rows out, then shut off the water and move to another set. This may mean one more irrigation during the course of a season. Irrigating every other middle would appear to be advisable to prevent waterlogging the soil if hit by thunderstorms after irrigating. This would necessitate more irrigations which may be unfeasible if gated pipe needs to be moved. Moving pipe causes one to schedule irrigations by the ability to move pipe rather than the needs or capabilities of the soil or plant. The use of flowmeters can help to determine furrow stream sizes and number of gates to open. Tailwater recovery pits are also a possibility if runoff from large irrigated areas can be captured. (See also W91-05137) (Fish-PTT)
W91-05159

TREE/PASTURE INTERACTIONS AT A RANGE OF TREE DENSITIES IN AN AGROFORESTRY EXPERIMENT: I. ROOTING PATTERNS.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 2I.
W91-05161

MICROBIAL POPULATIONS OF A SOUTHERN CHERNOZEM AS AN INDICATOR OF IRRIGATION EFFECTS.
Moscow State Univ. (USSR). Dept. of Soil Science.
S. N. Sukhova, G. M. Zenova, N. G. Zborishchuk, and D. G. Zvyagintsev.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 31-36, 1989. 4 tab, 11 ref.

Descriptors: *Bioindicators, *Irrigation effects, *Soil organisms, *Algae, *Soil water, *Chernozem, *Microorganisms, Species composition, Algal growth, Soil chemistry, Alkalinity, Species diversity, Biomass, Salinity, Cation exchange, Humus, Sodium.

The species composition and quantitative characteristics of algal populations may be used to indicate changes in the properties of southern Chernozem soils with irrigation. Irrigation leads to an increase in the numbers and biomass of algae and

to a wider diversity and change in dominant forms in the population. The controlling factors are the rate of irrigation and the degree of alkalinization of the soil. The numbers and composition of other microorganisms are affected to a lesser extent by irrigation. Changes in the composition of microbial population are correlated with wide variation in the properties of soil with irrigation, such as a decrease in the percent humus content of soil, increase in the total salinity, and an active uptake of sodium on the exchange complex of the soil. (Author's abstract)
W91-05217

WATER REGIME OF SHELTERBELTS IN A DRY STEPPE ZONE.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05218

SOIL FORMATION IN CULTIVATED, COARSE-TEXTURED SOD-PODZOLIC SOILS WITH CHEMICAL USE.
Velikie Luki Agricultural Inst., Lenina (USSR).
For primary bibliographic entry see Field 2G.
W91-05220

RESPONSE OF PEANUT TO MOISTURE STRESS AND IRRIGATION.
Indian Inst. of Tech., Kharagpur. Dept. of Agricultural Engineering.
A. R. Kahn, and B. Datta.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 15-23, 1990. 3 tab, 6 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Legumes, *Moisture stress, *Peanuts, Agriculture, Evaporation, Loam, Nutrients, Plant growth, Precipitation, Water use efficiency.

The response of peanut (Arachis hypogaea L.) erect Cultivar SB 'XI' to moisture stress and irrigation in relation to three depths of irrigation (2, 4 and 6 cm) and I/E ratios (0.50, 0.75 and 1.00) was studied in a greenhouse on a sandy loam soil for two consecutive years. The I/E ratio is the ratio between a fixed depth of irrigation water (I) and cumulative pan evaporation (E) (from U.S. Weather Bureau Class A open pan), less rainfall since previous irrigation. The yield attributes and pod yield were significantly affected by both the depths of irrigation and I/E ratios. The water-use efficiency, which was calculated as the quantity (in kg) of pod produced per ha-cm of water used, was higher in the second year of experimentation. The higher I/E ratio was inferior in terms of water-use efficiency which indicates that frequent irrigation is wasteful for both water and nutrients. An I/E ratio of 0.75 was found to be the optimum irrigation index for potential yield and water-use efficiency in the prevailing agro-climatic conditions. A depth of 6 cm is considered the best irrigation depth to ensure adequate moisture in the effective root zone. The above combination should result in the maximum yield potential of peanut. (Author's abstract)
W91-05475

EFFECT OF IRRIGATION SCHEDULE ON SOIL TEMPERATURE.
Indian Inst. of Tech., Kharagpur. Dept. of Agricultural Engineering.
A. R. Kahn, and B. Datta.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 24-31, 1990. 6 tab, 11 ref.

Descriptors: *India, *Irrigation, *Irrigation programs, *Legumes, *Soil temperature, Evaporation, Laterites, Loam, Peanuts, Percolation, Permeability, Plant growth, Precipitation, Soil porosity, Thermocouples.

Soil temperatures were measured at 5, 10, 15 and 20 cm depth throughout the growing season under crops of peanut (Arachis hypogaea L.) on a lateritic sandy loam soil (ultisol) to study the influence of irrigation water on soil temperature. Temperatures were measured with copper thermocouples buried at two random sites of each plot and located between plants near the center of an inside row. Soil temperatures at all the depths were monitored at 8:00 a.m. and 3:00 p.m. throughout the growth phases of the peanut crop. Temperatures of soil were also measured during and after irrigation. The damping effect of rain on soil temperature was large, quick and of shorter duration in the upper layers while the reverse was true for the deeper layers. It has been reported that irrigation or rain can cause a significant decrease in soil temperature by evaporative cooling from the soil surface for a relatively long period after irrigation. The Kharagpur sandy loam soil is highly permeable. Free percolation seems to have the effect of equalizing the temperature of the soil at various depths. Irrigation was modified according to depths of irrigation and IW/CPE ratios, where IW represents irrigation water and CPE represents cumulative pan evaporation minus rainfall. Differences between treatments were small and in most cases not significant. The IW/CPE ratio of 0.75 with an irrigation depth of 6 cm gave the highest peanut yield. It was concluded that a suitable moisture regime in soil maintained through irrigation will help in modifying soil temperature and water for better crop growth. (Agostine-PTT)
W91-05476

EFFECT OF POLYVINYL ALCOHOL, DEXTRAN AND HUMIC ACID ON SOME PHYSICAL PROPERTIES OF A CLAY AND LOAM SOIL: I. CRACKING AND AGGREGATE STABILITY.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
For primary bibliographic entry see Field 2G.
W91-05480

EFFECT OF POLYVINYL ALCOHOL, DEXTRAN AND HUMIC ACID ON SOME PHYSICAL PROPERTIES OF A CLAY AND LOAM SOIL: II. HYDRAULIC CONDUCTIVITY AND POROSITY.
Consiglio Nazionale delle Ricerche, Pisa (Italy). Ist. per la Chimica del Terreno.
For primary bibliographic entry see Field 2G.
W91-05481

EFFECTS OF PRICING POLICIES ON WATER CONSERVATION AND DRAINAGE.
California Univ., Santa Barbara. Dept. of Economics.
For primary bibliographic entry see Field 6C.
W91-05484

ROOT GROWTH AND WATER UPTAKE BY WHEAT DURING DRYING OF UNDISTURBED AND REPACKED SOIL IN DRAINAGE LYSIMETERS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2I.
W91-05493

ALTERNATIVE METHODS OF ESTIMATING WATER DEFICIT STRESS OF WHEAT GROWN ON UNDISTURBED AND REPACKED SOIL IN DRAINAGE LYSIMETERS.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2I.
W91-05494

PHYSIOLOGICAL ATTRIBUTES ASSOCIATED WITH DROUGHT RESISTANCE OF WHEAT CULTIVARS IN A MEDITERRANEAN ENVIRONMENT.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel).
For primary bibliographic entry see Field 2I.
W91-05496

EFFECT OF LEAF NITROGEN AND WATER REGIME ON THE PHOTOSYNTHETIC CAPACITY OF KENAF (HIBISCUS CANNABINUS L.) UNDER FIELD CONDITIONS.
Commonwealth Scientific and Industrial Research Organization, St. Lucia (Australia). Div. of Tropical Crops and Pastures.
For primary bibliographic entry see Field 2I.
W91-05497

CORRELATION OF GROWTH OF THE ROOT AND SHOOT SYSTEMS OF WHITE CLOVER AFTER A PERIOD OF WATER SHORTAGE AND/OR DEFOLIATION.
Kyabram Research Inst. (Australia).
For primary bibliographic entry see Field 2I.
W91-05498

HEALTH GUIDELINES AND STANDARDS FOR WASTEWATER REUSE IN AGRICULTURE: HISTORICAL PERSPECTIVES.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
For primary bibliographic entry see Field 5D.
W91-05535

CHEMICAL ANALYSIS OF IRRIGATION WATERS IN BAHRAIN.
Bahrain Univ., Manama. Dept. of Chemistry.
M. S. Akhter.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2159-2164, 1991. 3 tab, 11 ref.

Descriptors: *Bahrain, *Irrigation water, *Water quality, Acidity, Alkalinity, Calcium, Chemical analysis, Chlorides, Conductivity, Dissolved solids, Groundwater quality, Hydrogen ion concentration, Magnesium, Minerals, Nitrates, Phosphates, Physical analysis, Potable water, Potassium, Saline water, Sodium, Sulfates, Water analysis, Water pollution.

The State of Bahrain is an archipelago composed of 33 islands, with a total areas of 690.86 square km. The main resources of water in Bahrain are distilled water and underground water. Prior to 1925, fresh water was derived from 12 land and 24 offshore springs. The most important spring is Adari pool. It is used for domestic, agricultural and recreational purposes. Water quality and suitability of spring water, with special emphasis on Adari Spring, for agricultural purposes in Bahrain was investigated. A total of 24 chemical and physical parameters including pH, electrical conductivity, alkalinity, acidity, hardness, calcium, magnesium, sodium, potassium, sulfate, chloride, nitrate, phosphate, fluoride, iron, manganese, and total dissolved solids were analyzed. The data show that this water is chemically unacceptable for drinking purposes. However, the water could be used for agricultural purposes, particularly for date plantations which can tolerate high salinity water. Saline water and other possible pollutants are entering the spring water, deteriorating its quality. Groundwater quality in this spring should be continuously monitored. Treated sewage water was also analyzed for physical and chemical parameters. The data show promising results for agricultural purposes. Application of treated sewage water for agricultural purposes is still at an experimental stage. (Mertz-PTT)
W91-05545

ESTABLISHMENT AND PRODUCTION OF LUCERNE ON A SALINISED CLAY SOIL IRRIGATED WITH A MODERATELY SALINE GROUNDWATER.
Victoria Dept. of Agriculture and Rural Affairs, Tatura (Australia). Inst. for Irrigation and Salinty Research.
For primary bibliographic entry see Field 3C.
W91-05552

AGRONOMIC STUDIES ON THE PRODUCTIVITY OF KENAF (HIBISCUS CANNABINUS L. CV. GUATEMALA 4) UNDER RAINFED AND IRRIGATED CONDITIONS IN THE NORTHERN TERRITORY.
Commonwealth Scientific and Industrial Research

Organization, St. Lucia (Australia). Div. of Tropical Crops and Pastures.
R. C. Muchow, J. D. Sturtz, M. F. Spillman, G. E. Routley, and S. Kaplan.
Australian Journal of Experimental Agriculture AAAHAN, Vol. 30, No. 3, p 395-403, 1990. 3 fig, 7 tab, 26 ref.

Descriptors: *Agronomy, *Australia, *Crop yield, *Fiber crops, *Irrigation, *Irrigation design, *Kenaf, *Plant-water relationships, *Precipitation, *Productivity, *Soil-water-plant relationships, Biomass, Comparison studies, Fertilizers, Field tests, Nitrogen, Nutrients, Plant growth, Seasonal variation.

Field experiments were conducted at Berrimah, Douglas Daly and Katherine in the Northern Territory (NT) of Australia during the 1987-88 and 1988-89 wet seasons to obtain yield data for kenaf (Hibiscus cannabinus L, cv. Guatemala 4) grown under rainfed and irrigated conditions. Under rainfed conditions, maximum stem yield was obtained from sowings early in the wet season. Yield decreased with delay in sowing until the late December-January period. The maximum rainfed stem yield at Katherine in an above-average rainfall season was 18400 kg/ha. The maximum yield in a below-average rainfall season was 11700 kg/ha Douglas Daly and 9400 kg/ha at Katherine, 9200 kg/ha at Berrimeh. The applicability to the NT of growth and yield relationships established for irrigated kenaf in the Ord Irrigation Area (OIA) was assessed. The yield potential under irrigated conditions in the NT (21600 kg/ha at 131 days after sowing) was higher than that reported elsewhere in Australia for the same growth period, but similar to that reported elsewhere for longer growth duration (180-300 days). In the NT, in contrast to the OIA, stem yield showed little or no response to N uptake, and fertilization. Stem yield was not related to N uptake, and at high levels of N application, there was marked N accumulation in the stem. Kenaf was able to accumulate up to 110 kg N/ha from the soil reserve where no N was applied. The yield response to plant density varied with the yield level and was similar to that in the OIA. Bark and core yield could be estimated directly from biomass, and indirectly from stem length and plant density, over a wide range of yield levels and cultural conditions. It was concluded that data relating to yield potential and response to N fertilization cannot be transferred directly from the OIA to the NT. (Author's abstract)
W91-05553

UREA LOSSES IN FLOODED SOILS WITH ESTABLISHED OXIDIZED AND REDUCED SOIL LAYERS.
Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences.
K. R. Reddy, E. D'Angelo, C. Lindau, and W. H. Patrick.
Biology and Fertility of Soils BFSOEE, Vol. 9, No. 4, p 283-287, 1990. 4 fig, 2 tab, 18 ref. U.S. Agency for International Development Grant DAN-1406-G-SS-4091-00.

Descriptors: *Fertilizers, *Flooding, *Irrigation, *Rice, *Soil chemistry, *Ureas, Ammonia, Anaerobic conditions, Denitrification, Environmental chemistry, Hydrolysis, Leaching, Nitrification, Organic matter, Oxidation, Soil properties, Soil types.

It is well established that flooded rice soils are characterized by an oxidized surface layer (thickness is inversely related to the organic matter content of the soil) and an underlying anaerobic soil layer. Both oxidized and reduced soil layers can significantly influence urea hydrolysis and subsequent N loss from soils. Urea is highly unstable when added to these soils because it is rapidly hydrolyzed to NH4(+)-N and subsequently removed through: (1) plant uptake, (2) ammonia volatilization, (3) nitrification-denitrification, and (4) leaching. The fate of 15-N labelled urea applied to the floodwater in four soils with established aerobic and anaerobic soil layers, was determined through laboratory batch incubation experiments. Diffusion dependent urea hydrolysis was found to be rapid in all four soils, with rates ranging from 0.0107 to 0.0159/h and a mean rate of 0.0131/h. Rapid loss of 53-65% of the applied labelled urea occurred during the first 8 days after application, primarily by ammonia volatilization. At the end of 70 days, an additional 20-30% of applied labelled urea was lost, primarily through nitrification-denitrification processes. The soil types showed statistically significant differences in overall N recovery from the applied urea. The applied 15-N labelled urea recovery was in the range 11.2-19.5%, in the order: Coimbatore > Crowley > Cuttack > Yolo soils. This was probably due to differences in soil organic carbon content and cationic exchange capacity. Detection of 15-N labelled N2 in the headspace provided direct evidence of urea conversion to N2 as a result of urea hydrolysis, nitrification, and denitrification. (Agostine-PTT)
W91-05554

DEVELOPMENT OF A MICROBIAL COMMUNITY ON CELLULOSE BURIED IN WATERLOGGED SOIL.
Tokyo Univ. (Japan). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 2G.
W91-05555

SOIL WATER EFFECTS ON THE USE OF HEAT UNITS TO PREDICT CROP RESIDUE CARBON AND NITROGEN MINERALIZATION.
Agricultural Research Service, Orono, ME. New England Plant, Soil and Water Lab.
For primary bibliographic entry see Field 2G.
W91-05556

HUMIDITY AND SOIL WATER INFLUENCE THE TRANSPIRATION RESPONSE OF MAIZE TO CO2 ENRICHMENT.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 2D.
W91-05557

GENERALIZED RESULTS FROM CROP YIELD MODEL WITH SALINE WATERS.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W91-05601

PHOSPHORUS BEHAVIOR IN FLOODED-DRAINED SOILS: I. EFFECTS ON PHOSPHORUS SORPTION.
California Univ., Davis. Dept. of Agronomy and Range Science.
For primary bibliographic entry see Field 2G.
W91-05602

PHOSPHORUS BEHAVIOR IN FLOODED-DRAINED SOILS. II. IRON TRANSFORMATION AND PHOSPHORUS SORPTION.
California Univ., Davis. Dept. of Agronomy and Range Science.
For primary bibliographic entry see Field 2G.
W91-05603

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: I. SEEDLING GROWTH AFFECTED BY SOIL WATER POTENTIAL.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05607

MODELING WHEAT SEEDLING GROWTH AND EMERGENCE: II. COMPARISON WITH FIELD EXPERIMENTS.
Institut Agronomique et Veterinaire Hassan II, Rabat (Morocco). Dept. of Soil Science.
For primary bibliographic entry see Field 2I.
W91-05608

CONDITIONS FOR SUCCESSFUL IRRIGATION PROJECTS IN AFRICA.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
P. W. Zgheib.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 61-70, 46 ref.

Descriptors: *Africa, *Agricultural practices, *Desertification, *Irrigation programs, *Sahel, *Tropical hydrology, *Water resources development, Dam effects, Developing countries, Irrigation effects, Irrigation practices, Land use, Public health.

The development of irrigation projects in Africa is closely linked to the environment as well as to human activities. Projects can fail to produce the intended agronomic benefits. A study on the effects of hydro-agricultural systems on the environment six years after its implementation in the Sahel of Africa has shown a decrease in structural stability of the soil and an impoverishment in soil minerals. Fertility potential is reduced and eventually becomes the limiting factor of the system. The main causes of desertification is the growing influence of humans and of domestic animals and not climate change. Some of the activities that contribute to desertification are: increase of cultivated areas; overgrazing; destruction of ligneous woody species; wild fires; wells that become grazing concentration points; and unwise development of irrigation. Dams have been proposed as a solution to desertification. Their intended benefits include: flood control; irrigation potential; water availability; electrical energy; and recreation. Adverse consequences of dams on the human environment include: nuisances of the construction site; disturbance of aesthetics and natural harmony; animal migration out of the reservoir area; hazards due to equipment around the reservoir and river; and risk to downstream population if the dam fails. In the planning of irrigation systems, evaluation of potential impact of the newly enlarged water volumes on human health and hygiene is only common sense. Public health and population displacement concerns must be dealt with at an early stage of the design process. Construction effects and the introduction of irrigated agriculture also must be evaluated at the planning phase of a project in terms of interaction with local resources. Transportation of irrigation waters might result in creation of new human settlements which, if not planned carefully, will create unhealthy conditions, disruption of fauna and flora, disturbance of animal migratory systems and creation of favorable conditions to the development of irrigation enemies such as salt concentration and soil saturation. (See also W91-05611) (Lantz-PTT)
W91-05618

ESTIMATION OF TOTAL WATER CONSUMPTION OF SELECTED VEGETABLE CROPS IN THE SEMIARID AND HUMID REGIONS OF PUERTO RICO.
Puerto Rico Univ., Mayaguez.
M. R. Goyal.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 207-215, 2 tab, 10 ref. USDA Contract No. 85-CSRS-2-2664 (Project CBAG-23).

Descriptors: *Evapotranspiration, *Humid areas, *Plant-water relationships, *Puerto Rico, *Semiarid lands, *Tropical hydrology, *Vegetable crops, *Water use, Beans, Cabbage, Carrots, Climatic data, Corn, Cucumbers, Eggplant, Lettuce, Melons, Okra, Onions, Peppers, Potatoes, Pumpkins, Tomatoes, Tropical regions.

Total water consumption by 15 vegetable crops was estimated with a modified (USDA-SCS) Blaney-Criddle utilizing available climatic data from the semiarid south coast (AES-UPR Fortuna substation) and humid north coast (AES-UPR Isa-

bela substation) of Puerto Rico. Estimates were made for normal and dry years. Vegetable crops were: green bean, cabbage, carrot, sweet corn, cucumber, eggplant, lettuce, melons, okra, onion, sweet pepper, potato, pumpkin, sweet potato and tomato. In normal years, consumptive use (CU) at Fortuna was greater than CU at Isabela for all planting dates, all crop durations and vegetable crops. At Fortuna, total CU (inches per season) ranged from 6.1 for 60 days to 29.8 for 180 days. In all cases, the total CU range at Fortuna was 6.6 to 7.6% higher than the total CU range at Isabela. Among 24 planting dates, vegetable crops, and crop durations, the daily CU range (inches per day) was 0.10 to 0.19 at Fortuna, and 0.09 to 0.18 at Isabela. (See also W91-05611) (Author's abstract)
W91-05632

ECONOMIC AND ENGINEERING CONSIDERATIONS FOR PLANNING MEDIUM SCALE IRRIGATION SYSTEMS: A STUDY FROM NORTHEAST THAILAND.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
S. H. Johnson, and S. Patamatamkul.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 217-226, 3 fig, 2 tab, 17 ref.

Descriptors: *Economic aspects, *Irrigation engineering, *Irrigation practices, *Irrigation programs, *Social aspects, *Thailand, *Tropical hydrology, Agriculture, Case studies, Huai Aeng Reservoir, Irrigation canals, Irrigation efficiency, Rice, Seasonal variation, Water resources management.

Less than 50 percent of the area irrigated by the Huai Aeng Reservoir in northeastern Thailand can actually be utilized in the dry season. This means that the extremely-expensive on-farm distribution system is underutilized and farmers are uncertain whether they should plan to farm during the dry season or search for off-farm employment. Chance-constrained programming was utilized to determine the optimal service area for the reservoir. In contrast to the present situation where both the wet and dry season service areas are 3371 ha, the optimal design (taking into account rainfall variability) was 3371 ha for the wet season, but only 1179 ha in the dry season. Economic analysis shows that an irrigated area of 2192 ha using canals for extensive wet season rice, and 1179 ha using intensive canals and ditches for dry season field crops as well as wet season rice, is economically more efficient. This approach identified an area that can be served almost every year, which means that farmers can develop marketing strategies and adopt new agricultural practices with the certainty that the irrigated area will in fact have water when it is needed. (See also W91-05611) (Lantz-PTT)
W91-05633

PERFORMANCE OF STABILIZATION RESERVOIRS AS A FUNCTION OF DESIGN AND OPERATION PARAMETERS.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 5D.
W91-05759

MICROBIOLOGICAL PERFORMANCE OF MULTI-STAGE STABILIZATION PONDS FOR EFFLUENT USE IN AGRICULTURE.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05760

RESERVOIR PLANNING FOR IRRIGATION DISTRICT.
Iran Univ. of Science and Technology, Tehran. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W91-05791

EFFECT OF THE MELIORATIVE STATE OF IRRIGATED LANDS OF THE CHU RIVER VALLEY ON THE WATER-SALT REGIME AND YIELD.
All-Union Scientific Research Inst. of Fodder, Frunze (USSR). Agrometeorological Station.
Y. I. Demchenko, and M. K. Kaplinskiy.
Soviet Soil Science SSSCAE, Vol. 21, No. 2, p 69-75, 1989. 4 tab, 23 ref. Translated from Pochvovedeniye, No. 12, p 130-135, 1988.

Descriptors: *Chu River Valley, *Crop yield, *Irrigation effects, *Saline groundwater, *Saline soils, *Soviet Union, *Water table, Alfalfa, Fertilizers, Grain crops, Maize, Mathematical models, Soil types, Soil water table, Sugar beets, Toxicity.

In the Chu River valley (Soviet Union), sulfate salinity is the most common type of salinity for ordinary sierozems, meadow sierozems, and sierozem meadow soils. Permissible and toxic values of total toxic salts from a water extract and soil solution concentration have been determined for sugar beet, and literature data were used to develop correction factors for salt tolerance of sugar beet (1.0), alfalfa (1.26), corn (0.91), and unirrigated cereal crops (0.55). Parameters of the soil salt regime (toxic salt content from a water extract and soil solution concentration) are considered for principal crops of the Chu River valley. Relationships were demonstrated between yield and soil salinity, humus content, and groundwater depth and mineral content. Permissible limits of toxic salt content from a water extract and soil solution concentration for plants and variable salt tolerances and corresponding reductions in crop yields have been determined. From the relationships (equations) developed between soil parameters and yields, it was possible to determine the effect of remedial measures on computed crop yield. Based on these relationships the permissible depths to the water table were established for sugar beet for medium (1.68 m to 2.17 m) and clay loam (2.50 m to 3.22 m) soils with mineral content of groundwater ranging from 1 to 2 g/L. Optimum and toxic parameters of the soil salt regime are not fixed. They increase with increasing amounts of organic and mineral fertilizers. (Rochester-PTT)
W91-05826

NONLINEAR CHANCE CONSTRAINED MODEL FOR IRRIGATION PLANNING.
Asian Inst. of Tech., Bangkok (Thailand).
G. N. Paudyal, and A. D. Gupta.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 87-100, July 1990. 1 fig, 2 tab, 19 ref.

Descriptors: *Agriculture, *Irrigation, *Irrigation design, *Model studies, *Nonlinear programming, *Water management, Irrigation efficiency, Optimization models.

The production function for a crop is defined as the mathematical function providing the relationship between resource input and crop yield. Although many of these resource inputs can be controlled by man, a few, such as the climate variables, are difficult to control. Also, the timing of the resource inputs is an important issue which significantly affects crop yield. A general nonlinear optimization model for irrigation planning and management comprising a production function, chance constraints due to stochastic streamflows and a loss function to represent the economic implications of the chance constraints is proposed. The chance constraints and the loss function which are originally in the form of cumulative probability distribution functions of the streamflow are transformed into equivalent nonlinear deterministic forms. The focus of the chance constraints is to capture the variability in streamflows and, therefore, water available for irrigation. Through the use of chance constraints, the model first includes the full benefits attainable from irrigation then subtracts those benefits that are not actually achieved because the amount of water supplied was less than the optimum. With accurate data acquisition and the availability of sophisticated computing techniques, this nonlinear model will be useful as a management tool even in the developing countries. (Feder-PTT)
W91-05922

CROP COEFFICIENTS OF SOME MAJOR CROPS OF THE NIGERIAN SEMI-ARID TROPICS.
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Soil Science.
S. Abdulmumin, and S. M. Misari.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 159-170, July 1990. 7 fig, 21 ref.

Descriptors: *Agricultural hydrology, *Crops, *Grain crops, *Nigeria, *Semiarid lands, *Soil-water-plant relationships, Cotton, Humidity, Solar radiation, Temperature, Water requirements.

Crop coefficient curves for grain sorghum, cotton, maize, groundnut ad millet were developed for the Nigerian semi-arid tropics based on grass reference crop evapotranspiration (ETo) determined with the FAO-24(penman) procedure and lysimeter measured crop water use data from Samaru, Nigeria. The recommended equation for estimating solar radiation from relative sunshine hours was determined using measured solar radiation data. A value of 1.6 was obtained for the ratio day to night time wind speeds for the growing season (May to October) using an automatic weather station. A procedure was also developed to estimate daily minimum and maximum relative humidity from daily minimum and maximum temperatures and the usual relative humidity records. The crop coefficient curves developed can be recommended for use in farm water management decisions throughout the semi-arid tropics of West Africa south of the Sahara. (Author's abstract)
W91-05927

WATER USE AND YIELD RELATIONSHIPS OF IRRIGATED POTATO.
Bangladesh Agricultural Research Inst., Joydebpur.
T. Islam, H. Sarker, J. Alam, and H.U. Rashid.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 173-178, July 1990. 2 fig, 3 tab, 6 ref.

Descriptors: *Bangladesh, *Evapotranspiration, *Irrigation, *Irrigation design, *Irrigation requirements, *Potatoes, *Soil-water-plant relationships, *Vegetable crops, Irrigation efficiency, Water use.

An experiment was conducted at Joydebpur, Bangladesh, during the dry seasons of 1986-1987 and 1987-1988 with potato cultivar 'Cardinal' in order to determine the water requirements and to identify the yield respons of the crop to different irrigation regimes. Four treatments: no irrigation, irrigation at 80%, 60%, and 40% depletion of available soil moisture (ASM) were tested. For both the years five irrigations at 40% depletion of ASM gave maximum yield (22.3 t/ha) which was significantly different from the other treatments. On average 40 mm water was applied at an interval of around 12 days starting from 30 days after planting. The same treatments resulted in a maximum number of stems per hill, highest foliage coverage and maximum number of compound leaves; and maximum weight and number of tubers as percentage of total yield in the range of 28-45 mm and > 45 mm in size. It also resulted in maximum overall water use efficiency of 81.0 kg/ha mm, irrigation water use efficiency of 79.5 kg/ha mm. The non-irrigated treatment gave the highest percentage of tubers smaller than 28 mm. (Author's abstract)
W91-05928

TRANSIENT HYDRAULIC MODELING FOR IMPROVED CANAL SYSTEM OPERATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
G. P. Merkley, W. R. Walker, and F. N. Gichuki.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 181-194, September 1990. 7 fig, 5 tab, 8 ref. U.S. Agency for International Development Contract AID/DAN-4127-C-00-2086-00.

Descriptors: *Computer models, *Hydraulic models, *Irrigation canals, *Thailand, Canal operation, Irrigation efficiency, Water management.

A hydraulic model was developed to stimulate and help manage branching canal systems. Gate scheduling, one of the three operational modes available in the model, determines control structure and turnout settings with the objective of quickly stabilizing transient flow conditions, while maintaining flow levels at or near target values. Gate scheduling can be accomplished through manual control structure operation, without infrastructure changes or automation equipment. Following field calibration, the model was applied to the scheduling of canal operations at an irrigation project in northeast Thailand. Field and model-generated data showed that significant operational improvements for canal networks can be achieved with the model. Operational guess work is eliminated altogether and water deliveries can be more equitable to farmers because intended allocations are closely matched, and effective lag times are reduced or eliminated. During adjustments to new flow rates or reallocation of flows within the system, the water levels remain at or near their target values in each canal reach. Implementation of interactive transient hydraulic modeling on microcomputers make it available to most irrigation projects. (Author's abstract))
W91-05929

DESIGN OF STORAGE TANKS FOR WATER HARVESTING IN RAINFED AREAS.
Dryland Research Station, Hoshiarpur (India).
For primary bibliographic entry see Field 8A.
W91-05930

EFFECT OF INTERMITTENT IRRIGATION ON GROUNDWATER TABLE CONTRIBUTION, IRRIGATION REQUIREMENT AND YIELD OF RICE IN MOLLISOLS OF THE TARAI REGION.
Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Soil Science.
H. S. Mishra, T. R. Rathore, and R. C. Pant.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 231-241, September 1990. 2 fig, 2 tab, 11 ref.

Descriptors: *Crop yield, *India, *Irrigation, *Irrigation effects, *Irrigation requirements, *Rice, *Water management, Tarai Region.

Rice plants were subjected to six water irrigation treatments before havesting in the Tarae Region of India. The treatments were: continuous submergence of 5 plus or minus 2 cm water, completely rainfed, and 7 cm irrigation applied 1,3,5 and 7 days after the water vanished from the surface of the soil. The results demonstrated that under the conditions of the Tarai region where the water table remains shallow (<30 cm) for most part of the rice growing season, optimum yield (55-60 kg/ha) with high water use efficiency (3.21-3.67 kg/ha/mm) can be obtained by intermittent irrigation 3 to 5 days after the water vanished from the surface of the soil under shallow water tables and 1 to 3 days under medium water table conditions instead of continuous submergence, a practice traditionally followed in the Tarai region. (Author's abstract) (Feder-PTT)
W91-05932

POTENTIAL ECONOMIC RETURNS TO IMPROVED IRRIGATION INFILTRATION UNIFORMITY.
Rhode Island Univ., Kingston. Dept. of Resource Economics.
D. Wichelns, and J. D. Oster.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 253-266, September 1990. 1 fig, 6 tab, 23 ref.

Descriptors: *California, *Cotton, *Crop yield, *Infiltration rate, *Irrigation, *Saline soils, *Sodic soils, *Soil chemistry, Boron, Conductivity, Economic evaluation, Molybdenum, San Joaquin Valley, Selenium, Water conservation.

Field-level data describing cotton yields, irrigation and soil salinity and sodicity for 32 surface irrigated fields in the Broadview Water District in California's San Joaquin Valley are examined. The soils data indicate considerable infiltration variability with consequent negative effects on water availability for plant growth. Cotton yields range from 1.23 to 2.05 Mg ha and are negatively correlated ($p<0.05$) with the mean and standard deviation of salinity and sodicity parameters measured at twenty sites in each field. Yields are also negatively correlated ($p<0.15$) with the standard deviation of transmissivity measured in aerial photographs of the fields. A cotton production function that includes the observed mean and standard deviation of soil conductance is estimated. Results of the study suggest that cotton yields can be increased by 1.8% when observed variation in soil conductance is reduced by 10%. The estimated values of the increased cotton yields that would result from a 10% and 50% reduction in the variation of soil conductance are US$46/ha and US$231/ha, respectively. These increased returns from cotton production provide a measure of the economic incentive for farm-level adoption of irrigation practices that improve infiltration uniformity and reduce generation of subsurface drainwater. (Author's abstract)
W91-05934

EFFECT OF IRRIGATION SCHEDULING ON GROWTH, YIELD AND EVAPOTRANSPIRATION OF WHEAT IN SODIC SOILS.
Central Soil Salinity Research Inst., Karnal (India).
D. K. Sharma, A. Kumar, and K. N. Singh.
Agricultural Water Management AWMADF, Vol. 18, 3, p 267-276, September 1990. 3 fig, 4 tab, 11 ref.

*Irrigation effects, *Irrigation practices, *Crop yield, *Sodic soil, *Evapotranspiration, *Wheat, *Sodium, Hydrogen ion concentration, Karnal, *India.

To evaluate the critical growth stage for irrigation scheduling of wheat (Tririum acestivum L.), a field experiment was conducted at Karnal, India during the winter season of 1986-87 and 1987-88 in a sodic soil with pH 9.2 and exchangeable sodium percent 38. An increase in the irrigation frequency resulted in greater relative growth rate, rooting density, productive tiller per meter, and grain yield of wheat. The three irrigations given at crown root initiation, tillering and milk stage gave significanlty higher grain yield as compared to other treatments with three irrigations. The evapotranspiration (ET) of the crop increased as the crop season advanced and reached its peak from 60 to 90 days after sowing. Maximum water use efficiency was recorded when three irrigations were given at crown root initiation, tillering, and milk stage rather than other growth stages. Most of the ET occurred from the 0-15 cm soil layer and increased from lower layers (15-30, 30-60, and 60-90 cm soil depth) with an increase in the irrigation frequency, however, the total amount of ET from all the layers was always greater under higher irrigation frequency. (Author's abstract).
W91-05935

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

ACUTE TOXICITY OF THE NATURAL ALGICIDE, CYANOBACTERIN, TO DAPHNIA MAGNA.
Minnesota Univ., Minneapolis. Div. of Environmental Health.
For primary bibliographic entry see Field 5G.
W91-05105

PROCEEDINGS, TWENTIETH MISSISSIPPI WATER RESOURCES CONFERENCE, 1990.
Mississippi Water Resources Research Inst., Mississippi State.
For primary bibliographic entry see Field 2E.
W91-05137

EFFECTS OF CLEARING AND SNAGGING ON PHYSICAL CONDITIONS OF RIVERS.
Memphis State Univ., TN. Dept. of Civil Engineering.
R. H. Smith, and F. D. Shields.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 41-51, 4 fig, 2 tab, 20 ref.

Descriptors: *Aquatic habitats, *Bank clearing, *Channel improvement, *Channel morphology, *Flood frequency, *Riparian vegetation, *Rivers, *Snag removal, *Tennessee, Channel scour, Deposition, Dispersion coefficient, Environmental impact, Land clearing, Litter, Low flow, Mississippi.

Clearing and snagging (removal of bank vegetation and large woody debris from channels) may be used for reducing the stage and duration of high frequency flooding. Environmental impacts occur because riparian vegetation and the organic debris it produces influence the stream morphology, water quality, and aquatic and terrestrial habitats. Pilot data were collected from a reach of the South Fork Obion River near Bradford, Tennessee, in Gibson, Weakley, and Carroll Counties. Selective clearing and snagging had measurable effects on physical habitat characteristics of the South Fork Obion River. Relative to the two reference unworked reaches, the cleared reach had shallower depth, higher velocity, and slightly coarser substrate at low-flow conditions less preferable to many warm-water sportfishes. Removal of snags produced more uniform flow and less of the channel was occupied by eddies or regions of reduced velocity. Shannon indices and dispersion coefficients indicated that snags created eddies and areas of local acceleration and deceleration of flow and attendant zones of scour and deposition; removal of snags evidently reduced habitat diversity. The physical habitat diversity data were grouped into points with cover and points without cover, and physical differences were obvious. Points without cover always had sandy bed material; all of the fine material and litter that was found was associated with cover (primarily snags). These results are consistent with previous findings, and imply that impacts of the ongoing South Fork Obion River Project are being ameliorated through the use of selective techniques. (See also W91-05137) (Fish-PTT)
W91-05141

INFLUENCE OF GREENTREE RESERVOIR MANAGEMENT ON OVERSTORY COMPOSITION, CANOPY DENSITY, AND HARDWOOD REGENERATION ON NOXUBEE NATIONAL WILDLIFE REFUGE.
Mississippi State Univ., Mississippi State. School of Forestry.
For primary bibliographic entry see Field 6G.
W91-05149

EFFECT OF SIBERIAN RESERVOIRS ON THE ENVIRONMENT.
V. S. Kuskovskii, and Y. B. Trzhtsinskii.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 64-68, 1990. 12 ref.

Descriptors: *USSR, Hydraulic engineering, *Dam effects, *Reservoir operation, *Hydroelectric plants, *Environmental impact, Reservoir sites, Economic aspects, Economic development, Economic impact, Geohydrology, Engineering geology, Siberia.

The intense economic development of Eastern Siberia is in many respects determined by the creation of cascades from large reservoirs. The presence of negative consequences (substantial change in the natural conditions of the banks; flooding and

subirrigation of valuable farmland, forest, and populated areas; formation of a new shoreline; actively developing erosion of the banks; landslide; karst processes; piping; sinking) when constructing reservoirs confirms the urgent need for more thorough study in order to develop various methods to reduce this negative impact. Study of the zone of influence of reservoirs should concentrate on: study of the dynamics of the earth's crust caused by creation of reservoirs; knowledge of the natural engineering-geological processes; quantitative evaluation and prediction of formation of banks and slopes; study of the effect of the operating regime on the formation of the reservoir banks and its consequences on facilities located in the bank zone; detailed elaboration of the network of hydrogeological field monitoring stations; new methods of investigation (such as aerial photography); study of the change in the natural conditions in the lower pools; development of economically-justified recommendations on nature conservation in the zone of influence; and development of technical measures for protecting banks from destruction. A detailed engineering-geological and hydrogeological evaluation of reservoir creation in Siberia will make it possible to solve not only socioeconomic problems of the rational disposition of facilities in reservoir zones but also to provide measures for protecting the existing flora and fauna, keeping the air and water clean, and protecting the subsurface hydrosphere and the entire geological environment. (Fish-PTT)
W91-05302

UNBIASED ESTIMATION OF PROBABILITY WEIGHTED MOMENTS AND PARTIAL PROBABILITY WEIGHTED MOMENTS FROM SYSTEMATIC AND HISTORICAL FLOOD INFORMATION AND THEIR APPLICATION TO ESTIMATING THE GEV DISTRIBUTION.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 2E.
W91-05434

WATER-TABLE FLUCTUATIONS IN WEATHERED CRYSTALLINE ROCKS IN A HIGH ALTITUDE HUMID INTERTROPICAL ZONE (HIGH PLATEAUX OF MADAGASCAR) (COMPORTEMENT PIEZOMETRIQUE DES NAPPES D'ALTERITES EN ZONE INTERTROPICALE HUMIDE D'ALTITUDE (HAUTS PLATEAUX DE MADAGASCAR)).
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 2F.
W91-05442

APPROXIMATIVE TECHNIQUES IN THE OPERATIONAL OPTIMIZATION OF THE MAHAWELI RESERVOIR SYSTEM IN SRI LANKA.
Agricultural Univ., Wageningen (Netherlands).
J. J. Bogardi, M. D. U. P. Kularathna, and R. Harboe.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 167-176, 2 fig, 3 tab, 14 ref.

Descriptors: *Computer programs, *Mahaweli Reservoirs, *Model studies, *Optimization, *Reservoir operation, *Sri Lanka, *Tropical hydrology, *Water resources management, Dynamic programming, Management planning, Simulation analysis, Stochastic analysis, Tropical regions.

Stochastic dynamic programming (SDP) using discretized state and decision variables has been found to be an excellent method to derive operation strategies for reservoir systems. In order to overcome the dimensionality problem of SDP, inherent in refined discretization and consideration of multiple reservoirs, simplifications in modeling the reservoir system configuration and/or iterative optimization techniques can be applied. The main cascade of multipurpose reservoirs in the Mahaweli River basin will serve as a case study to demonstrate the viability of these approximative techniques. The use of the composite reservoir concept, sequential optimization of subsystems within the cascade, iterative optimization/simulation techniques considering subsystems and individual reservoirs are compared with the three reservoir model taking the 3 major reservoirs into account simultaneously while considering Rantembe as a run-of-the-river power plant. Finally the efficiency of the SDP models is compared with that of the deterministic (incremental) dynamic programming (IDP) using the maximization of total annual energy generation as objective function and irrigation water demands as constraints. (See also W91-05611) (Author's abstract)
W91-05628

REAL TIME OPERATION OF A MULTIPURPOSE RESERVOIR DURING TYPHOON OCCURRENCE.
Agricultural Univ., Wageningen (Netherlands).
J. J. Bogardi, W.-C. Huang, and R. Harboe.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 177-186, 4 fig, 4 tab, 12 ref.

Descriptors: *Flood control, *Model studies, *Multipurpose reservoirs, *Reservoir operation, *Taiwan, *Tropical hydrology, *Typhoons, *Water resources management, Computer programs, Feitsui Reservoir, History, Hydrologic models, Management planning, Operational Mode Switch, Rainfall, Simulation analysis, Storms, Tropical regions.

An Operational Mode Switch (OMS) procedure was developed to provide a systematic framework for decisions about whether or not to operate in a long-term mode (conservation/supply type of operation) or in a short-term (flood control operation) mode. The method is tested in a case study of the Feitsui reservoir in Northern Taiwan. The OMS system is activated on receiving a typhoon warning. It is composed of a simulation model coupled with a decision model. The operation of the reservoir is simulated with deterministically forecasted inflow both with long-term stochastic dynamic programming based operational policy and with an adaptive flood control release policy aimed at reducing the flood peak. Operational performance is compared in terms of multi-attribute utilities. The viability of the OMS-based operation is shown by rerunning historical typhoon events in a pseudo real-time mode. (See also W91-05611) (Lantz-PTT)
W91-05629

RESERVOIR FILLING PLANS FOR TROPICAL RESERVOIRS--A CASE STUDY.
Army Engineer District, Jacksonville, FL.
J. Vearil, and J. Miller.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 187-196, 2 fig, 5 tab, 12 ref.

Descriptors: *Case studies, *Cerrillos Dam, *Reservoir operation, *Rockfill dams, *Tropical hydrology, *Tropical regions, Bucana River, Flood control, Hydrologic models, Management planning, Model studies, Portugues River, Puerto Rico, Simulation analysis, Surface water.

The US Army Corp of Engineers is currently constructing the Cerrillos Dam, a feature of the Portugues and Bucana Rivers Project, in Puerto Rico. When completed, this zoned rockfill dam will impound waters of the Cerrillos River to provide flood protection and water supply for the downstream areas. Initial reservoir filling is complicated by a variety of constraints including hydrologic characteristics of the watershed, hydraulic limitations of the outlet works, geotechnical concerns including embankment stability and rim leakage, and reservoir clearing requirements. The reservoir site is subject to flash flooding, due to steep slopes in the mountainous watersheds. The Cerrillos River streamflow is highly variable and mostly due to surface water runoff. Reservoir inflow is low, except for short periods of very high flow during floods. Reservoir filling is difficult due to the characteristics associated with the tropical hydrology of the region. Reservoir filling was simulated by using a hydrologic model with a period of record streamflow data from the dam site, and was useful in analyzing the impacts and effects of the various filling plans. (See also W91-05611) (Author's abstract)
W91-05630

TESTING STOCHASTIC DYNAMIC PROGRAMMING MODELS CONDITIONED ON OBSERVED OR FORECASTED INFLOWS.
Bureau of Environmental Protection, Taipei (Taiwan).
For primary bibliographic entry see Field 2E.
W91-05788

MODEL FOR INVESTMENT APPRAISAL OF GRASSLAND DRAINAGE SCHEMES ON FARMS IN THE U.K.
AFRC Inst. of Grassland and Animal Production, Hurley (England).
K. Dowle, and A. C. Armstrong.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 101-120, July 1990. 6 fig, 9 tab, 32 ref.

Descriptors: *Computer models, *Drainage, *England, *Grasslands, *Model studies, Agriculture, Controlled drainage, Drainage programs, Economic evaluation, Wales, Water management.

A model was constructed for investment appraisal of grassland drainage schemes on farms in England and Wales. The model is based on an empirical relationship which simulates grass production before and after drainage. Grass growth is estimated by assuming a theoretical maximum growth rate, which is modified daily for nonoptimal conditions of temperature, radiation, nitrogen fertilizer, weight of crop and water balance. The difference in the amount of herbage which can be utilized before and after drainage is also valued. Historical weather data for a given site are used to estimate the future annual benefits to the site. An analysis of the future discounted costs and benefits is calculated. The experimental basis used for the validation of the model is the drainage experiment at North Wyke, Devon. This site provides a detailed record of both the soil water regime and the grass production which are unique in England. The model is intended for use as a tool by those making decisions relating to drainage: whether to drain or not drain, and what the benefits of drainage (or penalties for non-drainage) may be. The results of this project indicate that the model simulates drained and undrained situations reasonably well. One limitation is the fact that the model can only consider situations in which the management strategy remains the same before and after drainage. (Author's abstract)
W91-05923

4B. Groundwater Management

COMPUTER METHODS FOR EVALUATING WELLHEAD PROTECTION AREAS.
For primary bibliographic entry see Field 5G.
W91-05153

SUBSTITUTING CLIMATE FOR GROUNDWATER IN AQUACULTURE: THE POTENTIAL FOR CONSERVATION IN THE SOUTHEASTERN UNITED STATES.
Mississippi State Univ., Mississippi State. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 3F.
W91-05157

GROUND-WATER MANAGEMENT PROBLEMS IN THE NORTH CENTRAL COAST OF PUERTO RICO.
Puerto Rico Dept. of Natural Resources, San Juan.
S. N. Salgado, and F. I. Aponte.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 19-29, 2 fig, 1 tab, 2 ref.

Descriptors: *Groundwater management, *Groundwater protection, *Groundwater resources, *Management planning, *Puerto Rico, *Tropical hydrology, *Water use, Aquifers, Competing use, Drinking water, Economic aspects, Groundwater quality, Landfills, Regulations, Urbanization, Waste management, Water resources development.

An analysis of the groundwater management problems in the North Central Coast of Puerto Rico was undertaken because of the necessity for conserving and using, in an optimum manner, groundwater resources for the public benefit, for the economic development of this study area and for the urgency of establishing proper planning for the resource. The study area consists of the municipalities of Manati and Barceloneta on the north central coast of Puerto Rico. This area has been heavily developed because of the large quantity of quality groundwater, but it has consumed a large quantity of this groundwater. It is believed that the situation will worsen if no action is taken. The aquifer provides the only source of water for all of the various economic activities in this area. Recommendations for future management approaches include: (1) that a system for prioritizing the use of groundwater resources be established for all the users in the area; (2) that a new industrial policy be developed that would enforce the regions of storage, promote new methods for reducing the generation of hazardous wastes, promote the substitution of chemical substances that can threaten public health, and encourage efficient use of the groundwater resources and reuse of wastewaters; (3) that more restrictive drinking water standards be established for groundwater; (4) that current use of groundwater in the areas be determined; (5) that an attempt be made to rescue the aquifer recharge areas, in particular those of the artesian aquifer; (6) that users be made more aware of the vulnerability and sensitivity of the aquifer as soon as possible, both through education and mass media; (7) that the amount of water available and the exact location of the most productive areas be quantified; (8) that coordination between the EPA and the Puerto Rico Environmental Quality Board in the management and control of hazardous substances be improved; (9) that sanitary landfills be located such that wastes are not deposited nor stored in aquifer recharge areas; and (10) that plaguicide and herbicide use by pineapple farmers be carefully monitored and reduced whenever possible. (See also W91-05611) (Lantz-PTT)
W91-05614

SIGNIFICANCE OF CHEMICAL BOUNDARIES TO GROUND-WATER MANAGEMENT OF COASTAL AQUIFERS.
Geological Survey, Reston, VA.
W. Back, and J. S. Herman.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 31-38, 20 ref.

Descriptors: *Coastal aquifers, *Geochemistry, *Groundwater management, *Saline water intrusion, *Saline-freshwater interfaces, *Tropical hydrology, *Water quality, Boundary layers, Groundwater movement, Groundwater quality, Hydraulic head, Land use, Mixing, Permeability, Porosity, Tropical regions, Water chemistry.

One of the characteristics of tropical hydrology is the great number of islands in the tropical regions of the world. Because islands have a great ratio of coastline to land area, coastal phenomena have a far greater scientific and managerial significance for islands than for large land masses. For many coastal aquifers, the downgradient boundary of the freshwater system is commonly a chemical boundary, imposed by seawater encroachment into the aquifer. That interface represents a highly dynamic zone in which freshwater, ocean water, and the resulting mixed water come in contact with the aquifer material. Geochemical reactions that occur as a result of mixing water with different chemical compositions can significantly alter the distribution of porosity and permeability in the aquifer. The position of the interface determines the availability and quantity of fresh groundwater resources. The landward extent of saltwater intrusion is controlled largely by the magnitude and distribution of freshwater head. Land use practices that diminish the freshwater head can lead to degradation of quantity and quality of freshwater. Many tropical islands are developing nations with a high rate of population growth. Exploitation of natural resources will increase to meet demand and can have adverse effects on the groundwater supply. Potentially, deleterious practices and activities include deforestation, drainage, paving, and upgradient damming of streams. Because of the susceptability of coastal aquifers to saltwater encroachment and other contamination, water management problems are difficult and complex. However, the challenges can be met by formulation of policy and plans based on sound geohydrologic principles. (See also W91-05611) (Author's abstract)
W91-05615

DEVELOPMENT OF AN AQUIFER MANAGEMENT MODEL: AQMAN3D.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
J. C. Puig, L. I. Rolon-Collazo, and I. Pagan-Trinidad.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 39-48, 4 fig, 2 tab, 4 ref.

Descriptors: *AQMAN models, *Aquifers, *Computer programs, *Confined aquifers, *Groundwater management, *Groundwater movement, *Model studies, *Tropical hydrology, Aquifer systems, Data interpretation, Hydrologic models, Mathematical models, Simulation analysis, Water resources management.

A computer code that enables the use of the USGS Modular groundwater flow model for aquifer management modeling has been developed. Aquifer management techniques integrate groundwater flow modeling with linear quadratic optimization methods for the solution of various aquifer management problems. The model AQMAN3D, is a modified version of a previously developed two-dimensional AQMAN model. The idea of coupling the AQMAN model with the MODULAR model arose because actual groundwater flow systems behave in a three dimensional manner, therefore requiring treatment as such, and due to the widespread use of MODULAR. The use of the AQMAN3D model permits the implementation of the technique known as aquifer management modeling. A generalized approach to obtain an optimal solution to an aquifer management problem is proposed, and a sample test problem is presented to illustrate the use of the model. Even though the model provides the hydrologist with a new and powerful investigative tool, its applicability is limited to confined or quasiconfined systems. (See also W91-05611) (Author's abstract)
W91-05616

WELLHEAD PROTECTION: AN APPROACH TO PRESERVATION OF PUBLIC-WATER SUPPLIES.
Environmental Protection Agency, New York. Office of Ground-Water Management.
J. S. Malleck, and M. Albino.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 49-60, 4 fig, 8 ref.

Descriptors: *Administrative agencies, *Environmental protection, *Groundwater management, *Public policy, *Puerto Rico, *Tropical hydrology, *Water supply, *Wellhead protection, Economic aspects, Groundwater quality, Interagency cooperation, Land use, Legislation, Regulations.

A Wellhead Protection Program has been drafted and proposed by the Environmental Quality Board, the proposed lead environmental agency for the Commonwealth of Puerto Rico. Aspects of the US EPA Wellhead Protection Program, such as statute, technical considerations and implementation and management are addressed. Historical and present land use inventories are also identified. Demographic and economic realities of the land will necessarily shape the formulation and subsequent implementation of the wellhead protection strategy. In areas with limited economic and land resources, their most effective use needs to be achieved in order to attain effective protection goals. Deterioration of drinking water supplies and a growing population may require planning and protection strategies which address future development of untapped groundwater resources. Implementing a Wellhead Protection Program requires a multifaceted focus. There are complex technical issues, management issues, and negotiated decisions that must be addressed. Implementation requires the ability to gather, analyze, use, and share large amounts of information on geology, hydrology, public law, political climate, and other matters. The environmental agency's sister agencies that deal with public health, planning, and related matters, should also be involved. (See also W91-05611) (Lantz-PTT)
W91-05617

PROBLEMS OF GROUND-WATER DEVELOPMENT IN SMALL VOLCANIC ISLANDS IN THE EASTERN CARIBBEAN.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
For primary bibliographic entry see Field 2F.
W91-05637

APPLICATION OF GROUND-WATER ARTIFICIAL RECHARGE IN A BRACKISH/SALT-WATER ENVIRONMENT.
CH2M Hill, Deerfield Beach, FL.
For primary bibliographic entry see Field 2F.
W91-05649

ARTIFICIAL GROUND-WATER RECHARGE, VENTURA COUNTY, CALIFORNIA.
Banner Associates, Inc., Grand Junction, CO.
B. R. Rose.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 387-393, 2 fig, 1 tab.

Descriptors: *Artificial recharge, *California, *Groundwater management, *Groundwater recharge, *Operating policies, *Tropical hydrology, *Water use, Groundwater level, Groundwater quality, Groundwater resources, Industrial water, Irrigation, Saline water intrusion, Ventura County, Water supply.

For more than 60 years, the United Water Conservation District and its predecessor district have recharged seven groundwater basins in Ventura County, California, with more than 2,500,000 acre-ft/year of runoff water to maintain groundwater levels and quality, and control seawater intrusion. The district operates: a 90,000 acre-ft reservoir; a hydroelectric generating plant; three spreading grounds; a river diversion structure; a well field,

reservoir, booster plant, and pipeline for municipal and industrial water; an irrigation-water pipeline and regulating reservoir; and a surface and groundwater system to retard seawater intrusion. Experience has revealed three significant factors which are critical for optimizing infiltration rates: (1) use of recharge water that is low in suspended solids, (2) scheduling of spreading-pond use to allow a wet/dry cycle, and (3) maintaining the ponds in the best possible condition to receive water. (See also W91-05611) (Author's abstract)
W91-05650

SILTATION OF RESERVOIRS IN AGRICULTURAL WATERSHEDS DETERMINED USING RADIOISOTOPE TECHNIQUES.
Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab.
For primary bibliographic entry see Field 2J.
W91-05658

NUMERICAL SIMULATION OF SUBSURFACE-WATER RISE IN KUWAIT CITY.
Kuwait Inst. for Scientific Research, Safat.
For primary bibliographic entry see Field 2F.
W91-05825

4C. Effects On Water Of Man's Non-Water Activities

EXTENDING THE CAPABILITY OF THE COMPONENT INTERACTION MATRIX AS A TECHNIQUE FOR ADDRESSING SECONDARY IMPACTS IN ENVIRONMENTAL ASSESSMENT.
Cape Town Univ. (South Africa). Dept. of Environmental and Geographical Science.
For primary bibliographic entry see Field 6G.
W91-04965

OIL AND GAS ACTIVITY AND LOUISIANA WETLAND LOSS.
Louisiana State Univ., Baton Rouge. Dept. of Economics.
G. Foy.
Journal of Environmental Management JEVMAW, Vol. 31, No. 3, p 289-297, October 1990. 3 fig, 4 tab, 15 ref.

Descriptors: *Environmental impact, *Louisiana, *Natural gas, *Offshore platforms, *Oil industry, *Wetlands, Environmental effects, Environmental monitoring, Erosion, Model studies.

Two different methods were used to estimate the contribution of oil and gas activity in the Louisiana coastal zone and federal outer continental shelf region to Louisiana wetland loss in the period 1955-1980. The first method uses wetland scientists' consensus estimates of total oil and gas induced wetland loss to determine the average oil and gas related wetland loss per thousand barrels of oil-gas equivalent, and per well. Oil and gas wetland loss was also estimated by a time series method which did not use consensus estimates. This method's primary defect is the omitted variable problem. The time series estimates using production and well data respectively were 0:0060 acres/thousand barrels and 1:1797 acres per well. These were similar to the lower bound average estimates of 0:0060 acres/thousand barrels and 1-3658 acres/well. This similarity provides some support for the results of these two methods in an area of great uncertainty. (Lantz-PTT)
W91-04966

MICROBIOLOGY AND WATER CHEMISTRY OF TWO NATURAL SPRINGS IMPACTED BY GRAZING IN SOUTH CENTRAL NEVADA.
Nevada Univ., Las Vegas. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-05204

RAIN-RUNOFF PARAMETERS FOR SIX SMALL GAUGED URBAN CATCHMENTS.
Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering.
For primary bibliographic entry see Field 2B.
W91-05381

EFFECT OF DEICING SALTS ON TRACE METAL MOBILITY IN ROADSIDE SOILS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
C. Amrhein, and J. E. Strong.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 765-772, Oct-Dec 1990. 8 fig, 2 tab, 26 ref.

Descriptors: *Deicers, *Environmental effects, *Highway effects, *Highway icing, *Path of pollutants, *Trace metals, Biodegradation, Cadmium, Corrosion control, Leaching, Lead, Soil chemistry, Toxicity.

Calcium magnesium acetate (CMA) (Ca 0.3 Mg 0.7 (C2H3O2)2) is being used as an alternative to NaCl for deicing highways. CMA is an effective deicer, handles well, biodegrades, is less toxic to aquatic life, and is less corrosive than Cl salts. There is some concern, however, that CMA may increase the mobility of certain trace metals from roadside soils. Roadside soils were collected from around the USA from high-traffic and high-salt use areas. These soils were characterized for total trace metal content as well as important chemical and physical parameters. Studies were carried out to determine (i) the effect of CMA decomposition on Pb and Cd concentrations in as aqueous system (no soil), (ii) changes in major and minor element chemistry in soils incubated with NaCl and CMA solutions, and (iii) the mobility of trace metals from soil columns leached with solutions of deicing chemicals and/or H2O. Microbial decomposition of the acetate resulted in increased pH, CaCO3 or CdCo3 precipitation. There was no difference in trace metal solubility in soils treated with H2O or 10 mmol/L CMA or NaCl (average runoff concentration). Trace metal concentrations were initially high in soils treated with 100 mmol/L solutions of deicing salts but concentrations decreased with time due to adsorption or precipitation reactions. The leachability of Pb from soil columns was strongly correlated with organic matter solubilization. Soils leached with NaCl followed by distilled water had reduced permeabilities as compared to CMA-leached soils. It appears the effect of CMA on trace metal mobility in roadside soils should generally be beneficial. (Author's abstract)
W91-05408

INCREASE OF EARLY RAINS IN SOUTHERN ISRAEL FOLLOWING LAND-USE CHANGE.
Tel-Aviv Univ. (Israel).
For primary bibliographic entry see Field 2B.
W91-05409

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: AN ASSESSMENT OF THE RELATIVE EFFECTS OF ACID DEPOSITION AND AFFORESTATION.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5C.
W91-05437

HYDROLOGICAL RESPONSES TO URBANIZATION IN FORESTED LANANA CREEK WATERSHED NACOGDOCHES, TEXAS.
Stephen F. Austin State Univ., Nacogdoches, TX. School of Forestry.
M. Chang, and A. K. Sayok.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 131-140, 5 fig, 1 tab, 7 ref.

Descriptors: *Environmental effects, *Forest hydrology, *LaNana Creek, *Rainfall-runoff relationships, *Texas, *Tropical hydrology, *Urban hydrology, *Urbanization, *Water resources development, Flood peak, Flow profiles, Forest watersheds, Streamflow, Urban runoff.

Twenty-year (1965-84) USGS streamflow records for LaNana Creek in East Texas were broken down into 2 periods, an early period (1965-72) with little development, and a recent period (1973-84) with rapid urban development. A mass curve generated by plotting accumulated annual streamflow against accumulated annual precipitation revealed a significant difference in annual streamflow between these two periods. Simple statistics showed that the average annual streamflow of the recent period was 143 mm higher than that of the early period and was not totally attributable to differences in precipitation and temperature. Using a hydroclimatic calibration model for the early period, LaNana Creek streamflow was estimated to have increased 85.2 mm/year due to urbanization. Median daily flow was 0.07 cms for the early period versus 0.20 cms for the recent period. The recent period had a greater frequency of high flows, a smaller frequency of low flows and the monthly and annual maximum daily streamflows were greater. If storm characteristics were similar, peak flow is higher and direct runoff is greater in the recent period. The effects of urbanization on streamflow regimes in LaNana Creek were influenced by the short distance of the urbanized area to the gaging station, the sandy soils, and the destruction of forest environment. There were no significant changes in climatic conditions during the 20-year period. (See also W91-05611) (Lantz-PTT)
W91-05625

LAND DEVELOPMENT AND WATER QUALITY: THE CAYMAN ISLANDS STUDY.
Tennessee Univ., Knoxville.
G. E. Bowen, and T. R. Gangaware.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 443-453, 5 fig, 13 ref.

Descriptors: *Cayman Islands, *Corals, *Ecosystems, *Land development, *Land use, *Tropical hydrology, *Urban hydrology, *Water pollution sources, *Water quality, Case studies, Erosion, Islands, Potable water, Runoff, Urbanization, Water resources management, Wetlands, Wetlands restoration.

Teams of planners, ecologists, engineers and business students from the University of Tennessee studied the relationship between economic development and environmental protection in the Cayman Islands. They found the most interrelated elements were land development and water quality, with specific factors such as: water lenses and potable water supply, stormwater runoff and erosion, wetlands and swampland reclamation, and water clarity and reef ecology. The overall conclusion of the assessments was that the terrestrial and coral ecologies are interrelated with and dependent on water quality. The health of the coral reefs are related to the preservation of swamplands. Potable water is dependent on land development practices, waste disposal practice and swamp hydrology. Beach erosion is related to storm water removal, land development practices and reef decomposition. In the Caymans the mangrove swamps are ecologically productive and environmentally sensitive. Swampland reclamation and dredging are creating irreversible environmental damage to reef ecology. (See also W91-05611) (Author's abstract)
W91-05656

U.S. ARMY LAND CONDITION/TREND ANALYSIS OF THE POHAKULOA TRAINING AREA, HAWAII.
Colorado State Univ., Fort Collins. Dept. of Range Science.
R. B. Shaw, C. M. Bern, K. A. Schulz, V. E. Diersing, and D. J. Tazik.
IN: Tropical Hydrology and Caribbean Water Re-

sources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 455-464, 4 fig, 14 ref.

Descriptors: *Environmental effects, *Hawaii, *Land use, *Military reservations, *Monitoring, *Pohakuloa Training Area, *Tropical hydrology, Ecosystems, Erosion, Islands, Land development, Munitions wastes, Tropical regions.

Currently, the US Army Land Condition/Trend Analysis Program (LCTA) is being initiated at 13 installations worldwide. LCTA is designed to inventory vegetation and soil resources, to classify lands as to the kind and amount of use they can support, and to monitor the type and degree of use they receive. The Pohakula Training Area, Hawaii (PTA) is used as an example of how LCTA can be applied to a tropical ecosystem. Approximately 4% of the installation outside of the ordinance impact area has been disturbed by military training. Most of this military disturbance is at fixed firing points, bivouac sites, and unimproved roads. Disturbance by feral animals and hunting had the highest incidence of non-military land use. About 96% of the land available for training at PTA showed no disturbance by military activities. Wind and water erosion do not seem to be a major problem at PTA. Evidence of wind erosion was found on 13% of the area, while incidence of water erosion occurred on only 11% of the area. Plans are to continue to monitor military land use and changes in botanical composition due to training impacts. (See also W91-05611) (Author's abstract)
W91-05657

ENVIRONMENTAL ASSESSMENT OF HUMAN INTERFERENCE ON THE NATURAL PROCESSES AFFECTING THE BARRIER BEACHES OF LONG ISLAND, NEW YORK.
Hofstra Univ., Hempstead, NY. Dept. of Geology.
F. Wolff.
Northeastern Environmental Science NOESDE, Vol. 8, No. 2, p 119-134, 1989. 10 fig, 73 ref.

Descriptors: *Barrier islands, *Coastal zone management, *Environmental impact, *Land development, *New York, Bays, Beach erosion, Beaches, Dredging, Dunes, Erosion control, Estuarine environment, Natural resources, Shore protection, Shores.

Development of the urban and suburban communities on the Long Island, New York, barrier beaches led to the recognition of coastal erosion problems 50 years ago, and to the use of structural and nonstructural methods to promote stabilization in areas that have such problems. Transgressive barrier islands, during a time of rising sea level, need to periodically undergo inlet breaching and dune overwash during major storms to develop the bay marsh for landward migration of all of the environments on the island. The determination of inhabitants to promote stabilization and prevent these natural processes from occurring has only aggravated the coastal erosion problems. There is less likelihood of landward sand migration in the short-term, but a greater possibility for lateral and offshore sand movement in the long-term. An examination of early and recent maps, recent aerial photographs, and field observations shows that the original narrow, sinuous, and elongate barrier with low dunes has, with the onset of stabilization and dredging efforts, been widened and filled in on the bay side and eroded and truncated along the seaward margin. Most areas will need to undergo extensive narrowing (i.e., further beach and dune erosion) before overwash deposition and inlet formation can again enable the natural landward barrier island migration. The best long-term solution for these barrier islands is the abandonment of the beach-dune-washover environment whenever manmade structures are destroyed by storms, the lowering of dune elevations in some areas, the opening of new inlets, and the reestablishment of the back-barrier marshes by either natural or artificial means. This would enable the 'leap-frog' process that would be commensurate with natural barrier island migration. (Author's abstract)
W91-05797

PARTICLE TRACKING ANALYSIS OF RECHARGE AREAS ON LONG ISLAND, NEW YORK.
Geological Survey, Trenton, NJ.
For primary bibliographic entry see Field 5B.
W91-05822

NUMERICAL SIMULATION OF SUBSURFACE-WATER RISE IN KUWAIT CITY.
Kuwait Inst. for Scientific Research, Safat.
For primary bibliographic entry see Field 2F.
W91-05825

IMPACT OF MAN.
Johns Hopkins Univ., Baltimore, MD.
M. G. Wolman.
EOS EOSTAJ, Vol. 71, No. 52, p 1884-1886, December 25, 1990. 3 fig, 1 tab.

Descriptors: *Environmental effects, *Hydrologic budget, *Industrial development, *Urbanization, *Water resources development, Agriculture, Channel accretion, Consumptive use, Ecological effects, Land use, Nutrients, Reservoirs, Riparian waters, Sediment transport, Water pollution effects.

There is no doubt that mankind is now altering the Earth significantly and that no part of the global system is immune. The envelope of air surrounding the globe, the oceans--which cover about 70% of the surface--the land surface, the subsurface, and the biosphere all feel the impact of man. The transformation from agriculture to industry in the modern world is seen in the rapid rise of urbanization along with technology and industry. For example, in Latin American the urbanized population exceeds 80%. Even in China and India, clearly agricultural countries, more than 20% of the population live in urban areas. This combination of energy-utilizing technology, urbanization, and population growth imposes formidable demands on the global system. Agriculture and reservoir construction have markedly altered the hydrologic balance of the globe. Since 1680, the base flow of rivers has increased on the order of 20%, while surface runoff has decreased by about 16% and total runoff by 6%. The estimated increase in consumptive use of water for irrigation has been roughly 300-fold in a similar period. Reservoirs not only alter the water regime of rivers, they alter the riverine landscape as well. In the United States the channel bed downstream from major reservoirs and dams has been lowered about 1-3 m. Channels starved of the sediments trapped in the reservoirs erode their banks, often for hundreds of miles downstream. Similar conditions have been observed in many other parts of the world. Where the bed is lowered, the hydrology and ecology of the bottomlands are markedly altered, and manmade works such as bridge piers, water intakes, and buildings may be undermined. Water pollution of rivers, lakes, estuaries, and oceans is increasing in most parts of the world. While improvement in selected reaches of rivers is evident, for example, in the Potomac, Hudson, and Delaware rivers, progress is limited over many areas as industrialization and changes in land use impact rivers of the world. Levels of nutrients supplied to coastal waters of the United States have increased by several tens of percent. (Rochester-PTT)
W91-05872

ENVIRONMENTAL IMPACT OF GOLD MINING INDUSTRY IN GHANA.
Ghana Univ., Legon. Dept. of Physics.
S. A. Bamford, E. Osae, I. Aboh, C. A. Biney, and L. A. Antwi.
Biological Trace Element Research BTERDG, Vol. 26/2, p 279-285, July/December 1990, 3 fig, 3 tab, 7 ref.

Descriptors: *Environmental impact, *Ghana, *Gold mining, *Mine wastes, *Path of pollutants, *Sediment contamination, *Water pollution sources, Atomic adsorption spectroscopy, Heavy metals, Particulate matter, River sediments, X-ray fluorescence.

Gold ore and gold tailings are some of the identified pollution sources in the gold-mining industry. X-ray fluorescence (XRF) analysis and atomic absorption spectrophotometry (AAS) were used in assessing heavy metal pollution from some gold mines in Ghana. The presence and levels of heavy metals in gold ore, gold tailings, inland waters, and river sediments were determined. Using these techniques, the heavy metals: Cr, Mn, Fe, Cu, Zn, As, Pb, Rb, Sr, Y, Zr, and Nb were identified in some of the solid samples within a concentration range of 0.08 ppm-4.9%. However, the inland waters showed the presence of only Fe and Zn at levels of 0.08-2.4 micrograms/ml. This indicates that most of the heavy metal pollutants exist in particulate form and do not go into solution, but rather settle into the sediments of the inland waters. (Author's abstract)
W91-05896

4D. Watershed Protection

OCCURRENCE OF VEGETATED BUFFER ZONES ALONG BROOKS IN THE CATCHMENT AREA OF LAKE TUUSULANJARVI, SOUTH FINLAND.
For primary bibliographic entry see Field 5G.
W91-05064

VEGETATED BUFFER ZONE EXAMINATIONS ON THE VANTAA RIVER BASIN.
Water Protection Association of the Vantaa River and Helsinki District (Finland).
H. Ahola.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 65-69, 1990. 2 fig, 11 ref.

Descriptors: *Buffer zones, *Catchment areas, *Erosion control, *Finland, *Vantaa River, *Water pollution control, Agricultural runoff, Bank erosion, Nonpoint pollution sources, Stream banks, Vegetation.

The vegetated buffer zone is one way reducing the non-point pollution load caused by agriculture. The Water Protection Association of the Vantaa River and Helsinki District (Finland) currently has a study project of vegetated buffer zones in progress. The project aims to find methods of examining vegetated buffer zones and erosion of river banks, to test those methods in practice, and to give recommendations and instructions on how to construct various types of vegetated buffer zones. The examination consists of five parts including map and field investigations. Special attention has been paid to the breadth of buffer zones, slope of surface, sensitivity to erosion, vegetation, and cultivation methods. The methods were tested in the Vantaa River basin in Southern Finland. Typical of the examined and problematic areas is a narrow buffer zone between field and river bed. The breadths of the vegetated buffer zones also varied considerably. Vegetation has developed poorly, especially on slopes that have been cleared out. The slopes of cleared ditches are very steep and ditch banks can collapse into streams, blocking the stream again. Pipes in the ditches would be a better solution. However, management of vegetated buffer zones is not the only answer to pollution problems in these drainages. The nutrient load of the entire cultivated agricultural land must be reduced. The conclusion of this study can be applied in river basins where the percentage of field is considerably higher than the percentage of lake. (Rochester-PTT)
W91-05065

SOIL CONSERVATION FUNCTIONS OF STEPPE FOREST PLANTATIONS.
Engineering-Reclamation Institute of Gosagromprom SSSR, Novocherkassk.
V. M. Ivonin, and V. V. Zasoba.
Soviet Soil Science SSSCAE, Vol. 21, No. 6, p 26-38, 1989. 2 fig, 5 tab, 11 ref.

Descriptors: *Watershed management, *Erosion control, *Forest management, *Forest soils, *Reforestation, *Steppes, *Soil conservation, *Soil erosion, Plant growth, Soil depth, Runoff, Litter

accumulation, Humus, Soil texture, Rainfall, Soil aggregates.

Artificial forests, which are highly productive and form nodes of organic mass in regions with erosion potential, are the supporting subsystems in anti-erosion systems for watersheds (basins) of rivers in the steppe zone. The soil conservation functions of artificial steppe forests were studied with respect to the dynamics of the forest floor and the physical properties of the 0 to 20 cm layer of soil under broadleaf and light-coniferous plantations. Broadleaf stands on the better sites increase the soil's resistance to erosion mainly by the accumulation of the forest floor and increase in the water stability of soil aggregates. Light coniferous stands increase the soil-protective function of the forest by the accumulation of litter and the increase in the humus content and plasticity of the upper horizons of coarse-textured soils. With increasing stand age of both forest types, there is consistent increase in the mechanical stability of aggregates. Mathematical models have been developed for the relationship between the modulus of runoff of suspended sediment during rainfall and characteristics of the 0 to 20 cm layer of soil to determine the stand ages required to create and retain optimal forest floor mass under the forest canopy. (Brunone-PTT)
W91-05221

AMELIORATING EFFECT OF SHELTER-BELT FORESTS ON CHERNOZEMS.
Kazan State Univ. (USSR).
A. V. Koloskova.
Soviet Soil Science SSSCAE, Vol. 21, No. 6, p 48-55, 1989. 3 tab, 20 ref.

Descriptors: *Erosion control, *Soil absorption capacity, *Soil stabilization, *Shelterbelts, *Steppes, *Chernozems, Humus, Soil horizons, Biomass, Soil water, Root distribution, Soil aggregates.

Study of the effect of shelter belt forests on the properties of forest-steppe chernozems showed that the water stability of the structure of the chernozems increased two to three times. The amount of humus and energy in the humus increased by 30 to 35% relative to the control. Results showed that the content of the structural fraction larger than 1 mm tends to increase in the upper horizons of the soil under the belt but is very similar to that of the areas adjacent to the belt and the control. This result can be attributed to the high moisture content of the forested and immediately adjacent areas, strong development of forest vegetation with a thicker root system, and the lack of biomass removal from these areas. Thus, the effect of the shelter belts is to increase the content of water stable aggregates in the upper horizons of chernozems located under the belts and in adjacent areas. The ameliorating effect of forest belts on the chernozems suggests that the forest belts increase the chernozem's water absorbing ability and resistance to erosion. (Brunone-PTT)
W91-05222

GUIDELINES FOR VEGETATIVE EROSION CONTROL ON WAVE-IMPACTED COASTAL DREDGED MATERIAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
P. L. Knutson, H. H. Allen, and J. W. Webb.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report D-90-13, September 1990. Final Report. 89p, 26 fig, 4 tab, 42 ref.

Descriptors: *Erosion control, *Vegetation, *Coastal waters, *Dredging, *Salt marshes, Standards, Dredging wastes, Wave action, Bank stabilization, Wetlands.

Guidelines are provided that permit the evaluation of vegetative stabilization alternatives for dredged material disposal areas using salt marsh wetland plants. The guidelines provide a methodology for classifying dredged material shorelines with respect to wave energy (low, moderate, or high energy sites) and specify a vegetative stabilization strategy (standard planting techniques, root anchored techniques or wave protection structures) for each energy regime. Such guidelines provide dredged material planners and operations personnel, the means to use dredged material for the combined beneficial use of wetlands creation, habitat development, and erosion control. Two case studies present salt marsh creations on dredged material sites. These studies provide guidelines for creating salt marshes on moderate to high energy sites exposed to both ship and wind generated waves. (Author's abstract)
W91-05275

EROSION TESTS ON FOUR INTACT ONTARIO CLAYS.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W91-05366

FRAMEWORK FOR INCORPORATING STREAM USE IN THE DETERMINATION OF PRIORITY WATERSHEDS.
Wisconsin Univ.-Green Bay. Coll. of Environmental Sciences.
For primary bibliographic entry see Field 6D.
W91-05386

USING COMMON SENSE TO PREVENT SOIL EROSION FROM URBAN DEVELOPMENT AREAS.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
R. E. Zapata Lopez.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 71-80, 11 ref.

Descriptors: *Construction methods, *Erosion control, *Runoff, *Sediment load, *Soil erosion, *Tropical hydrology, *Urbanization, Land development, Land use, Rainfall-runoff relationships, Sedimentation, Tropical regions, Urban areas.

Urban areas in the tropics usually have streams crossing or flowing around them; these streams collect most of the runoff from the frequent rainfall events as well as the generated sediment loads. The sediments can be reduced or controlled if common sense is used during planning and design, construction, and post-construction activities of any urban project. Even though erosion due to rainfall and runoff is complex and difficult to quantify, application of common sense joined with concepts of hydraulics, hydrology, and soil characteristics can be used to reduce stream sediment loads and to control erosion from urban projects. The major effort in looking for solutions to the soil erosion problem should be during the planning stages of a project. Even though the construction stage generates the largest amount of sediment, there are ways to minimize it by using temporary controls. Even after the completion of a construction project the erosion process will be present; therefore, a preventive and maintenance program for the permanent conservation practices used in the project is a must. (See also W91-05611) (Author's abstract)
W91-05619

NUMERICAL SIMULATION OF SHORELINE CHANGE AT LORAIN, OHIO.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2J.
W91-05782

THEORETICAL PRINCIPLES OF WATER EROSION CONTROL ON CROPLAND.
V. P. Gerasimenko.
Soviet Soil Science SSSCAE, Vol. 21, No. 2, p 76-85, 1989. 2 tab, 15 ref. Translated from: Pochvovedeniye, No. 10, p 108-116.

Descriptors: *Cropland, *Erosion control, *Soil erosion, *Soviet Union, Agricultural runoff, Agronomy, Crop yield, Overland flow, Performance evaluation, Runoff, Snowmelt, Soil loss series, Soil moisture, Wheat.

A major portion of the agricultural lands in the Soviet Union are located in a zone of inadequate and variable moisture and, consequently, control of soil erosion should be based on efficient regulation of snowmelt runoff and storm runoff and on productive use of soil moisture to stabilize and increase crop yields. A concept of water erosion control is proposed that takes into account the reduction of soil loss to the level of natural soil formation, efficient redistribution of overland flow to maintain a favorable moisture regime for crops in the root zone, and replenishment of the underground water supply and small streams. New methods are proposed for evaluating the flow-regulating, erosion control, and agronomic effectiveness of soil conservation measures singly or in combination. The developed principles of water erosion control can be used in planning optimum systems of soil conservation farming ensuring higher yields of winter wheat by as much as 6-8 cntr/ha. The new method of evaluating the flow-regulating, erosion control, and agronomic effectiveness of soil conservation measures provides a means of decreasing four-fold the time required for determining which is the most effective from a zonal standpoint. To obtain objective water erosion characteristics during short-term observations, combined runoff and soil loss series must be constructed with regard to their independence and homogeneity. (Rochester-PTT)
W91-05827

ECONOMICS OF EROSION AND SEDIMENT CONTROL IN SOUTHWESTERN ONTARIO.
Guelph Univ. (Ontario). Dept. of Agricultural Economics and Business.
G. Fox, and E. J. Dickson.
Canadian Journal of Agricultural Economics, Vol. 38, No. 1, p 23-44, March 1990. 9 tab, 45 ref.

Descriptors: *Cost-benefit analysis, *Economic evaluation, *Erosion control, *Ontario, *Sediment control, *Soil conservation, Canada, Conservation tillage, Cropland, Economic aspects, Farm management, Model studies, Simulation analysis, Tillage, Water quality management.

Recent research has indicated that the off-farm costs of soil erosion are substantial. The use of conservation tillage has been suggested as one strategy to protect surface water quality in regions of intensive cropping. However, none of the previous studies use Canadian data to assess the water quality benefits of conservation tillage. The costs of off-farm damage from sediment displaced through erosion from southern Ontario, Canada, cropland were compared with the costs of erosion control to farmers using available conservation tillage techniques. The SOILEC model was used to simulate the long-run on-farm profitability of alternative tillage systems. The Guelph model for evaluating the effects of Agricultural Management systems on Erosion and Sedimentation (GAMES) was used to estimate changes in sediment delivery rates under different production systems. Results from the analysis indicate that the off-farm gains from the use of conservation tillage generally exceed the on-farm costs of erosion control for southwestern Ontario growing conditions. (Author's abstract)
W91-05849

COMBINING INDUSTRIAL WASTES WITH LIME FOR SOIL STABILIZATION.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-05867

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

STABILITY OF VOLATILE ORGANIC COMPOUNDS IN ENVIRONMENTAL WATER SAMPLES DURING TRANSPORT AND STORAGE.
Oak Ridge National Lab., TN. Analytical Chemistry Div.
M. P. Maskarinec, L. H. Johnson, S. K. Holladay, R. L. Moody, and C. K. Bayne.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1665-1670, November 1990. 8 fig, 5 tab, 14 ref. EPA Interagency Agreement 1744-1744-A1; DOE Interagency Agreement 1743-1743-A1; DOE Contract DE-AC05-84OR21400.

Descriptors: *Chlorides, *Laboratory methods, *Sample preservation, *Volatile organic compounds, *Water analysis, *Water sampling, Chemical degradation, Distilled water, Groundwater, Surface water.

Methods have been developed for the preparation of standard environmental water samples containing known concentrations of volatile organics. Three samples were used: distilled water, surface water and groundwater. Samples were stored at both room temperature and under refrigeration. Data were collected over a 365-day period by gas chromotography/mass spectrometry. Rapid dehydrohalogenation of tetrachloroethane to trichloroethylene occurred in the distilled water, surface water and groundwater samples stored at room temperature. Reduced aromatic volatiles were observed in both surface and groundwater matrices after 28 days. Loss of carbon tetrachloride was also apparent in surface water samples stored at room temperature. Experiments were conducted to determine the value of using HCl, sodium bisulfate and ascorbic acid as preservatives. Sampling and analytical considerations make the use of HCl impractical. Samples preserved with the other two acids were stable over the 112-day experimental period. (Feder-PTT)
W91-04947

AIRBORNE MERCURY DEPOSITION AND WATERSHED CHARACTERISTICS IN RELATION TO MERCURY CONCENTRATIONS IN WATER, SEDIMENTS, PLANKTON AND FISH OF EIGHTY NORTHERN MINNESOTA LAKES.
Minnesota Univ., Duluth. Coll. of Science and Engineering.
For primary bibliographic entry see Field 5B.
W91-04951

DISTINGUISHING DIPHENYLAMINE AND N-NITROSODIPHENYLAMINE IN HAZARDOUS WASTE SAMPLES BY USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY/THERMOSPRAY/MASS SPECTROMETRY.
Environmental Monitoring Systems Lab., Cincinnati, OH.
J. S. Ho, T. A. Bellar, J. W. Eichelberger, and W. L. Budde.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1748-1751, November 1990. 3 fig, 1 tab, 5 ref.

Descriptors: *Analytical methods, *Hazardous wastes, *Liquid chromatography, *Mass spectrometry, *Pollutant identification, *Soil analysis, Carcinogens, Soil contamination.

N-Nitrosodiphenylamine and diphenylamine in environmental samples cannot be easily distinguished and determined by conventional gas chromatography/mass spectrometry. By using a high-performance liquid chromatography/thermospray/mass spectrometry technique, these two compounds were directly distinguishable . Analytical results showed two distinct chromatographic peaks and distinct mass spectra of these two compounds. The method was applied to a soil sample from an abandoned hazardous waste site near Buffalo, NY and showed unequivocally that there was no N-nitrosodiphenylamine. However, 7400 mg/kg diphenylamine was found in the sample. The detection limit for both compounds is estimated to be about 15 ppm in a highly contaminated soil sample. (Feder-PTT)
W91-04956

POTENTIAL OF BASING AN ECOLOGICAL TYPOLOGY OF AQUATIC SEDIMENTS ON THE NEMATODE FAUNA: AN EXAMPLE FROM THE RIVER RHINE.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nematology.
T. Bongers, and J. Van De Haar.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 37-45, July 1990. 1 fig, 3 tab, 30 ref, append.

Descriptors: *Bioindicators, *Ecosystems, *Nematodes, *Rhine River, *River sediments, *Sediment contamination, Ammonia, Estuaries, Population density, Species composition, The Netherlands, Worms.

In Dutch River sediments, nematodes can occur in high numbers; azoic sediments are as yet unknown. In a series of samples taken from the Rhine River and its estuaries, nematode density varied from 5.0 to 1.7 million/sq m, and about 50 genera were identified. Anoxic conditions appear to have less influence on the nematode abundance than the presence of ammonia. Based on nematode genera, an ecological typology of aquatic soils would appear to be feasible. River sediments in The Netherlands can be separated into three pollution classes: azoic sediments in some harbor basins, sediments with only Tubificidae, and sediments with at least four tubificid species together with chironomids and mollusks. For the assessment of water quality, tubificids are considered to be relatively tolerant to pollutants and only have an indicator value in extreme cases of pollution. Nematode fauna have the potential to act as an additional instrument to develop an overall typology and assessment system of sediments and terrestrial soils. (Author's abstract)
W91-04960

PCB CONCENTRATIONS IN STREAM SUNFISH (LEPOMIS AURITUS AND L. MACROCHIRUS) IN RELATION TO PROXIMITY TO CHRONIC POINT SOURCES.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5B.
W91-04982

USE OF SEDIMENT BAGS AS A MONITOR OF FECAL POLLUTION IN STREAMS.
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
P. G. Nix, and C. H. Merry.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 864-869, December 1990. 2 fig, 2 tab, 10 ref.

Descriptors: *Bioindicators, *Fecal coliforms, *Monitoring, *Sampling, *Sediment bags, *Sediment contamination, Bacteria, Clostridium, Coliforms, Data acquisition, Fecal bacteria, Urban areas, Water quality.

Sediment and water were tested for two fecal indicators, fecal coliforms and Clostridium perfringens. Natural stream sediments were collected into sterile Whirl-Pac bags using a trowel previously washed in a dilute solution of bleach and rinsed in the downstream water. Fecal coliforms (FC) were enumerated using the three tube MPN (most probable number) technique with lauryl tryptose broth (LTB) and Escherichia coli (EC) broth and with results expressed in most probable number (MPN) per 100 grams of sediment. The sediment bags were suspended in the stream water during collection of natural sediments and sampled one week later. In a preliminary study of Shone Creek in North Vancouver, British Columbia, fecal coliforms were undetectable in both the water (<2 CFU/100 ml) and natural sediment (<3 MPN/100 g). However, fecal coliforms were detected at levels of 240 to 460 MPN/100 g in sediment bags. It is likely that the natural sediment did not show a positive result because it consisted of a coarse gravel which was presumably not capable of accumulating substantial numbers of bacteria through processes of adsorption or attachment. Water samples were similarly negative, probably a result of the inability of a single grab sample to detect transient fecal contamination events. Levels of C. perfringens were low (<4 MPN/100 g) in both natural sediments and sediment bags suggesting that much lower concentrations existed in the water column compared with fecal coliforms. Fecal contamination was much greater in three urban creeks (Parkside, Hastings, and McKay Creeks, all near North Vancouver: 140,000; 9,240; and 40,500 MPN/100 g, respectively) compared to Shone Creek, reflecting increased levels of contamination. In all cases, the sediment bags provided a more sensitive monitor for determining fecal contamination at upstream sites. (Lantz-PTT)
W91-05008

TOXICITY OF MERCURY TO THE FRESHWATER MALE AND FEMALE FIELD CRABS, PARATELPHUSA HYDRODROMOUS (HERBST) (DECAPODA: BRACHYURA).
Andhra Univ., Waltair (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W91-05013

PRELIMINARY OBSERVATIONS ON THE ECOLOGICAL RELEVANCE OF THE GAMMARUS 'SCOPE FOR GROWTH' ASSAY: EFFECT OF ZINC ON REPRODUCTION.
Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
L. Maltby, and C. Naylor.
Functional Ecology FECOE5, Vol. 4, No. 3, p 393-397, 1990. 4 fig, 23 ref.

Descriptors: *Analytical methods, *Bioassay, *Pollutant identification, *Toxicology, *Water pollution effects, *Zinc, Amphipods, Aquatic animals, Reproduction, Scope for growth assay.

'Gammarus scope for growth' is a 7-day assay that measures the effect of stress on the energy budgets of individuals. The effects of zinc on reproduction in the brooding female Gammarus pulex (L.) and on scope for growth (SfG) were investigated. The reproductive parameters measured were size and number of offspring released from one brood incubated under zinc stress (current brood) and another provisioned under zinc stress (subsequent brood). In both experiments, a significant effect was observed at 0.3 mg Zn/L. At this concentration, SfG was reduced, as a result of a decrease in energy absorbed, and there was a decrease in the size of offspring released from the subsequent brood. There was no effect on the size or number of offspring released from the current brood nor on the number of offspring in the subsequent brood. Moreover, both present and past zinc stress caused an increase in the number of broods aborted. It is concluded that stress-induced changes in SfG are indicative of more long-term effects on the organism, which in turn can be used to make predictions concerning the population as a whole. (Author's abstract)
W91-05041

CLONAL VARIATION IN GENERAL RESPONSES OF DAPHNIA MAGNA STRAUS TO TOXIC STRESS: I. CHRONIC LIFE-HISTORY EFFECTS.
Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
For primary bibliographic entry see Field 5C.
W91-05042

CLONAL VARIATION IN GENERAL RESPONSES OF DAPHNIA MAGNA STRAUS TO TOXIC STRESS: II. PHYSIOLOGICAL EFFECTS.

Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
For primary bibliographic entry see Field 5C.
W91-05043

EFFECTS OF TBT CONTAMINATION ON NUCELLA POPULATIONS.
Liverpool Univ., Port Erin (England). Dept. of Marine Biology.
For primary bibliographic entry see Field 5C.
W91-05045

ASSESSING THE IMPACT OF TIN AND TBT IN ESTUARIES AND COASTAL REGIONS.
Plymouth Marine Lab. (England).
For primary bibliographic entry see Field 5C.
W91-05046

USE OF CHEMICAL ANALOGUES SUCH AS EU/AM IN ECOTOXICOLOGICAL STUDIES.
Reading Univ. (England). Dept. of Zoology.
J. Bierkens, and K. Simkiss.
Functional Ecology FECOE5, Vol. 4, No. 3, p 445-447, 1990. 1 fig, 3 tab, 4 ref. NERC Grant GST/02/202.

Descriptors: *Americium, *Aquatic animals, *Bioaccumulation, *Bioassay, *Europium, *Path of pollutants, *Radioisotopes, Chemical analogs, Crabs, Crayfish, Crustaceans, Ecotoxicology, Toxicity.

The suitability of Eu-152 as a chemical analog for the radiotoxic Am-241 in ecotoxicological studies was examined in marine crabs (Carcinus maenas (L.)) and freshwater crayfish (Astacus leptodactylus). Both elements were strongly absorbed onto the surface of crabs and crayfish, although crayfish appeared to equilibrate more slowly in freshwater. The distribution of the isotopes in subcellular fractions of the digestive gland was also very similar and was dominated by their incorporation into the granular fraction. The results indicated that the environmental distribution of both Eu-152 and Am-241 is dictated by surface adsorption onto exoskeletons and cellular deposits. It is concluded that europium could be used as a chemical analog in ecotoxicological studies of americium distribution. Studies utilizing chemical analogues are recommended for tracing the distribution and bioaccumulation of xenobiotics in an ecosystem without the simultaneous problem of toxic effects. (MacKeen-PTT)
W91-05047

IMPOSEX INDUCTION IN NUCELLA LIMA (GMELIN) VIA MODE OF EXPOSURE TO TRIBUTYLTIN.
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
For primary bibliographic entry see Field 5C.
W91-05054

ANION-EXCHANGE CHROMATOGRAPHY PARTICLE BEAM MASS SPECTROMETRY FOR THE CHARACTERIZATION OF AROMATIC SULFONIC ACIDS AS THE MAJOR ORGANIC POLLUTANTS IN LEACHATES FROM STRINGFELLOW, CALIFORNIA.
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
I. S. Kim, F. I. Sasinos, R. D. Stephens, and M. A. Brown.
Environmental Science and Technology ESTHAG, Vol. 24, No. 12, p 1832-1836, December 1990. 3 fig, 4 tab, 12 ref.

Descriptors: *California, *Groundwater pollution, *Hazardous waste disposal, *Organic pollutants, *Pollutant identification, *Superfund, Chlorinated hydrocarbon insecticides, DDT, Hazardous wastes, Landfills, Leachates, Liquid chromatography, Mass spectrometry, Spectrophotometry, Sulfonic acids.

Anion-exchange liquid chromatography with detection via both particle beam mass spectrometry (electron impact and negative chemical ionization) and UV absorption spectrophotometry was used to characterize target and nontarget compounds in lyophilizates from three hazardous waste leachates from the Stringfellow, CA Superfund site: upstream, downstream, and charcoal-treated mixture. Lyophilization retains essentially all the organic carbon, which is 513, 46.8, and 453 ppm, respectively. Charcoal treatment removes priority pollutants but not most of the total organic carbon (TOC), which is primarily highly polar, nonextractable, and nonpurgeable material. Besides 4-chlorobenzenesulfonic acid (from 53-69% of the TOC), seven additional major aromatic sulfonic acids were tentatively identified. All are sulfonated and chlorinated byproducts, probably from DDT manufacture. Relative ratios of the aromatic sulfonic acids are not altered significantly by the charcoal treatment. The potential impact on human health of these highly polar halogenated organic compounds is unknown. (Author's abstract)
W91-05073

ESTIMATION OF POLYCHLORINATED DIBENZOFURAN AND DIBENZO-P-DIOXIN CONTAMINATION OF A COASTAL REGION USING ISOMER PROFILES IN CRABS.
Norsk Inst. for Luftforskning, Lillestroem.
For primary bibliographic entry see Field 5B.
W91-05074

CASE STUDY OF LEAD IN DRINKING WATER: PROTOCOL, METHODS, AND INVESTIGATIVE TECHNIQUES.
IBM Corp., Boulder, CO.
For primary bibliographic entry see Field 5B.
W91-05089

PHOSPHATE-SENSITIVE ENZYME ELECTRODE: A POTENTIAL SENSOR FOR ENVIRONMENTAL CONTROL.
Lyon-1 Univ., Villeurbanne (France). Lab. de Genie Enzymatique.
For primary bibliographic entry see Field 7B.
W91-05090

DETERMINATION OF RHENIUM IN GROUNDWATER BY INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY WITH ON-LINE CATION EXCHANGE MEMBRANE SAMPLE CLEANUP.
National Enforcement Investigations Center, Denver, CO.
M. E. Ketterer.
Analytical Chemistry ANCHAM, Vol. 62, No. 23, p 2522-2526, December 1990. 2 fig, 5 tab, 18 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Groundwater chemistry, *Mass spectrometry, *Rhenium, *Sample cleanup, *Water analysis, *Water chemistry, Cation exchange, Detection limits, Dissolved solids, Mine wastes, Sample preparation, Separation techniques.

A scheme was presented for determining rhenium by inductively coupled plasma mass spectrometry in groundwater samples that contain up to 4000 mg/L dissolved solids. A commercially available cation exchange membrane cartridge is used on-line to exchange cationic species for equivalent quantities of hydrogen ion; rhenium, which is present as the perrhenate anion, remains on the upstream side of the membrane and is transported directly into the inductively coupled plasma. This arrangement successfully alleviates the matrix-related sample introduction difficulties and permits direct determination of rhenium in water with a detection limit of 0.03 microg/L using a Meinhard-type nebulizer. Removal efficiencies of up to 100% are achieved for sodium, magnesium, aluminum, potassium, and calcium ions, while perrhenate is transmitted with 100% efficiency. Samples of groundwater from 40 monitoring wells in the vicinity of a metal sulfide tailings impoundment in the western United States contained rhenium in concentrations ranging from <0.03 to 2.97 microg/L. (Author's abstract)
W91-05091

DETERMINATION OF LINEAR ALKYLBENZENESULFONATES AND DIALKYLTETRALINSULFONATES IN WATER AND SEDIMENT BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY.
Monsanto Co., St. Louis, MO.
M. T. Trehy, W. E. Gledhill, and R. G. Orth.
Analytical Chemistry ANCHAM, Vol. 62, No. 23, p 2581-2586, December 1990. 6 fig, 4 tab, 38 ref.

Descriptors: *Analytical techniques, *Detergents, *Linear alkyl sulfonates, *Pollutant identification, *Surfactants, *Water analysis, *Water quality monitoring, Alkylbenzene sulfonates, Detection limits, Gas chromatography, Mass spectrometry, Sediment analysis.

A method for the determination of linear alkylbenzenesulfonates (LAS) and dialkyltetralinsulfonates (DATS) in water and sediment samples by gas chromatography/mass spectrometry (GC/MS) is described. Sulfonates are converted to their trifluoro sulfonate derivatives in a two-step derivatiztion procedure. In the first step the sulfonates are converted to the sulfonyl chlorides by treatment with phosphorus pentachloride. After extraction, the sulfonates are then converted to their corresponding trifluoroethyl derivatives by the addition of trifluoroethanol. Quantitation is by an internal standard technique with a C9 DATS as the internal standard. The derivatization GC/MS method permits the detection and quantitation of LAS and of DATS, which are minor components present in LAS. The limit of detection for both LAS and DATS in water by electron capture negative chemical ionization GC/MS is estimated to be 0.001 mg/L. In sediment the detection limit is 0.5 mg/kg for LAS and 0.2 mg/kg for DATS. Enhanced sensitivity and selectivity of the GC/MS method permit the detection of LAS and DATS at the low concentrations detected in environmental samples. (Author's abstract)
W91-05092

LIQUID CHROMATOGRAPHY-ELECTROCHEMICAL DETECTION OF INORGANIC ARSENIC USING A WALL JET CELL WITH CONVENTIONAL AND MICROSIZED PLATINUM DISK ELECTRODES.
Deakin Univ., Melbourne (Australia). Div. of Chemical and Physical Sciences.
R. S. Stojanovic, A. M. Bond, and E. C. V. Butler.
Analytical Chemistry ANCHAM, Vol. 62, No. 24, p 2692-2697, December 15, 1990. 6 fig, 2 tab, 56 ref.

Descriptors: *Analytical methods, *Arsenic, *Electrochemistry, *Electrodes, *Instrumentation, *Liquid chromatography, *Pollutant identification, *Water analysis, Bottled water, Detection limits, Oxidation, Performance evaluation, Platinum.

A critical evaluation of a highly sensitive and specific liquid chromatography amperometric detection method (wall jet cell) for the determination of arsenic has been undertaken with platinum disk electrodes of variable size. The limit of detection for arsenic is 5 nM using platinum disc electrodes of conventional size (mm radius) and 10, 20, 50 and 500 nM using microelectrodes of 50, 25, 12.5, and 2.5 micrometer diameter, respectively. Thus, the determination of arsenic is readily achieved in a bottled mineral water sample with a conventional size electrode, whereas the arsenic levels are too low to be detected precisely with a microelectrode. However, with respect to the desirable properties of a lower dependence on flow rate and a shorter time taken to achieve a stable baseline, and in cases where sensitivity is not a problem, the microelectrode method is advantageous. The method for detection involves a surface-based oxidation process in which As(III) is converted to As(IV). It is suggested that advantages and disadvantages offered by using microelectrodes as an alternative to conventionally sized electrodes are critically dependent on the mechanism of the electrode process. (Author's abstract)
W91-05093

CAN THE UNITED STATES AFFORD BIO-MONITORING.
For primary bibliographic entry see Field 5G.
W91-05143

DETERMINATION OF HEAVY METALS AND RADIOACTIVE ELEMENTS IN PURIFIER SLUDGE.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Chemistry.
For primary bibliographic entry see Field 5E.
W91-05209

ANALYSIS OF PETROLEUM CONTAMINATED SOIL AND WATER: AN OVERVIEW.
Massachusetts Univ., Amherst. Chenoweth Lab.
T. L. Potter.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 97-109, 2 fig, 2 tab, 23 ref.

Descriptors: *Pollutant identification, *Soil contamination, *Path of pollutants, *Oil pollution, *Analytical methods, *Leaks, Oil spills, Hydrocarbons, Data interpretation.

Spills, leaks, and other releases of gasolines, diesel fuels, heating oils, and other petroleum products often result in the contamination of soil and water. Analyses required to evaluate the extent of such releases and the threat they present to public health and the environment take a variety of forms. The least specific and most general analytical approach to the problem usually involves some form of 'total petroleum hydrocarbon' measurement. In contrast are analyses which are focused on selected target compounds. In this review article, the 'state-of-the-art' of petroleum contaminated soil and water analysis is discussed with emphasis on the US EPA Methods. Various examples demonstrate that the methods can be used effectively for this purpose but that problems do arise. The need for specific method development in this area is emphasized. (See also W91-05236) (Lantz-PTT)
W91-05245

ONSITE ANALYTICAL SCREENING OF GASOLINE CONTAMINATED MEDIA USING A JAR HEADSPACE PROCEDURE.
Massachusetts Dept. of Environmental Quality Engineering, Woburn. Div. of Hazardous Waste.
J. Fitzgerald.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 119-136, 13 fig, 1 tab, 6 ref.

Descriptors: *Analytical methods, *Gasoline, *Soil contamination, *Measuring instruments, Laboratory methods, Oil pollution, Path of pollutants, Data interpretation, Data acquisition, Ionization, *Field tests, Monitoring, *Instrumentation, *Pollutant identification, Volatile organic compounds.

Analytical and interpretative limitations exist in the utilization of portable photoionization detector (PID) and flame ionization detector (FID) response meters. Historically, improper and/or inconsistent use of these investigative tools has perhaps limited their acceptance and field utility. Preliminary data has been obtained to aid in the interpretation of analytical headspace screening data. Based upon an evaluation of field headspace development and 'probe insertion' sampling parameters, the following procedural elements are recommended: (1) utilize glass jars for field instrumentation which are between 9 and 16 oz. in capacity with sampling flow rates greater than 500 ml/min; (2) half-fill sample jars and seal with a clean sheet of aluminum foil; (3) agitate the sample jar for 30 seconds over a 5 to 10 minute headspace development period; and (4) quickly insert the PID or FID sampling probe through the aluminum foil seal and record the maximum meter response as the 'total organic vapor' headspace concentration. Maximum response should occur between 2 and 5 seconds when using a 9 oz. or 16 oz. jar. Erratic meter responses should be discounted. PID measurements above 150 ppm (v/v) TOV as benzene may be significantly nonlinear. (See also W91-05236) (Lantz-PTT)
W91-05247

PROBLEMS ASSOCIATED WITH ANALYSIS OF PETROLEUM-DERIVED MATERIALS IN THE ENVIRONMENT.
Iowa Univ., Iowa City. State Hygienic Lab.
P. A. Kostle, D. R. Seeger, and J. Knapp.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 137-148, 9 fig, 4 tab, 4 ref.

Descriptors: *Pollutant identification, *Water analysis, *Groundwater pollution, *Monitoring, *Analytical methods, *Oil pollution, *Path of pollutants, Data interpretation, Laboratory methods, Soil contamination, Measuring instruments, Chromatography, Ionization, Hydrocarbons, Gasoline, Benzenes, Toluenes, Xylenes.

The Iowa Department of Natural Resources requires that soil or groundwater samples from excavation sites of former underground storage tanks be analyzed to determine if contamination has occurred. Different techniques and detectors have been used to analyze these samples for gasoline, benzene, toluene, xylenes and total extractable hydrocarbons. Because of the Mixxor micro-extractor's unsuitability for solid matrices, high quantitation limits for direct extract analysis, and poor volatile aromatic recoveries for solvent concentration techniques, efforts to use solvent extraction procedures for hydrocarbon analyses were not continued. Current plans are to implement the use of purge and trap sample concentration and megabore capillary column gas chromatography with photoionization detector/flame ionization detector (PID/FID) in series to provide acceptable volatile aromatic quantitation limits while minimizing interferences and analytical delays caused by the presence of heavier hydrocarbons from products such as diesel fuel and motor oil. Identification and quantitation of heavier hydrocarbon contamination will continue to require solvent extraction and capillary column gas chromatography of an aliquot of the concentrated extract. (See also W91-05236) (Lantz-PTT)
W91-05248

GUIDANCE FOR CONTRACTING BIOLOGICAL AND CHEMICAL EVALUATIONS OF DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5E.
W91-05276

PROBABILISTIC SOIL CONTAMINATION EXPOSURE ASSESSMENT PROCEDURES.
Environmental Defense Fund, Austin, TX.
V. J. Smith, and R. J. Charbeneau.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1143-1163, November/December 1990. 5 fig, 2 tab, 22 ref, append.

Descriptors: *Environmental engineering, *Soil contamination, *Risk assessment, *Model studies, *Organic pollutants, *Groundwater pollution, Monte Carlo method, Simulation analysis, *Path of pollutants, Solute transport, Probability distribution, Population exposure, Uncertainty, Soil properties.

An exposure assessment procedure was examined to address the question of whether the presence of an organic chemical in soil poses a significant risk to an underlying groundwater supply. A comparison was conducted between Monte Carlo simulation and first-order uncertainty analysis within the framework of this scenario. For the exposure assessment procedure, the exposure point concentration was predicted by performing Monte Carlo simulation using a one-dimensional vertical, soil-water solute-transport model coupled with a two-dimensional, horizontal groundwater fate and transport model. The result was expressed as a probability distribution of the contaminant concentration at the point of human exposure (water supply well). To complete the exposure assessment procedure, the concentration corresponding to a prespecified risk level (usually 5%) was evaluated against the appropriate and/or relevant health-based standards for the site. First-order uncertainty analysis was tested as an alternative to Monte Carlo simulation for the exposure assessment procedure, and was found to be a useful tool for examining the relative importance of the various site parameters; however, the method was not found to be a substitute for Monte Carlo simulation in the context of this particular exposure assessment procedure, because of its inhomogeneous soil characteristics and vaguely-defined climate parameters. (Author's abstract)
W91-05326

ON-LINE DETERMINATION OF RESIDUAL ALUMINIUM IN POTABLE AND TREATED WATERS BY FLOW-INJECTION ANALYSIS.
Hull Univ. (England). Dept. of Chemistry.
R. L. Benson, P. J. Worsfold, and F. W. Sweeting.
Analytica Chimica Acta ACACAM, Vol. 238, No. 1, p 177-182, 1990. 4 fig, 5 tab, 17 ref.

Descriptors: *Water treatment, *Spectrophotometry, *Pollutant identification, *Aluminum, *Analytical techniques, *Water analysis, Potable waters, Flow injection analysis, Automation, Treated water, Monitoring, Metal complexes, Colloids, Detection limits, Metals.

One aspect of water quality monitoring is the determination of residual aluminum (Al) in potable and treated waters. Due to potential health risks, European community legislation set a MAC (maximum acceptable concentration) level of 200 micrograms/L and guideline level of 50 micrograms/L for Al. A portable, automated, flow-injection-based solid-state spectrophotometric field monitor for the determination of residual dissolved Al in potable and treated waters was designed. Aluminum is determined by complexation with pyrocatechol violet to form a colloidal lake with a maximum absorbance at 580 nm. Interference from iron(III) is masked by reduction to iron(II) and complexation with 1,10-phenanthroline. The monitor operates on a 30-min analytical cycle, i.e., with 48 results per day, and each cycle includes an autocalibration step. Over the course of a 3-month field trial the reliability was greater than 90%. The performance conforms to industry specifications for both overall accuracy (bias +/-10%) and repeatability (relative standard deviation < +/-10%), the linear range is 0 to 1000 micrograms/L, and the practical limit of detection is < 45 micrograms/L. A maintenance program would be scheduled around replenishment of reagents and the only other routine maintenance required is the replacement of pump tubing every 30 days. This Al monitor meets the performance characteristics specified by the water industry and is sufficiently rugged and reliable for field use. (Vernooy-PTT)
W91-05330

RAPID ION-EXCHANGE TECHNIQUE FOR THE SEPARATION AND PRECONCENTRATION OF CHROMIUM(VI) AND CHROMIUM(III) IN FRESH WATERS.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
C. A. Johnson.
Analytica Chimica Acta ACACAM, Vol. 238, No. 2, p 273-278, 1990. 2 fig, 1 tab, 24 ref.

Descriptors: *Ion exchange, *Separation techniques, *Analytical techniques, *Water analysis, *Chromium, *Pollutant identification, *Atomic absorption spectrophotometry, Resins, Detection limits, Preconcentration, Laboratory methods, Metals.

Chromium is present in fresh water systems in two thermodynamically stable oxidation states, Cr(VI) and Cr(III), depending on the redox conditions. A technique for the separation and preconcentration

of Cr(VI) and Cr(III) in fresh waters was developed. The analytical procedure involves the use of anion and cation-exchange columns. The columns are eluted and the eluate is analyzed for chromium using a graphite furnace atomic absorption spectrophotometer. Efficiency of the cation and anion-exchange columns was determined by the standard addition of chromium species to a lake water sample. The recovery of Cr(VI) and Cr(III) was 97.86 +/-1.31% and 102.36 +/-1.25% (95% confidence), respectively. The detection limits were 0.019 and 0.020 micrograms/L for 200 ml of sample (twice the standard deviation of eleven replicate blanks). This method is a rapid and reliable method for freshwater samples. Whereas such methodology previously required up to 24 hours from separation to analysis, several duplicate samples can now be ready for analysis within 1 hour. Minimum sample handling ensures that there is less likelihood of sample contamination. Also, relatively small sample volumes are required and large concentration factors are easily achieved. Future method development, however, will have to address the problem of total chromium determination and the characterization of the colloidal chromium fraction. (VerNooy-PTT)
W91-05332

ION CHROMATOGRAPHIC DETERMINATION OF TRACE AMOUNTS OF ALUMINIUM WITH ON-LINE PRECONCENTRATION AND SPECTROPHOTOMETRIC DETECTION.
Padua Univ. (Italy). Dipt di Chimica Inorganica, Metallorganica e Analitica.
A. Tapparo, and G. G. Bombi.
Analytica Chimica Acta ACACAM, Vol. 238, No. 2, p 279-284, 1990. 6 fig, 2 tab, 28 ref.

Descriptors: *Spectrophotometry, *Pollutant identification, *Aluminum, *Ion exchange chromatography, *Analytical techniques, *Water analysis, Detection limits, Metals, Preconcentration, Pollutant identification, Trace levels, Laboratory methods, Metal complexes.

Increasing awareness of the toxicity and ecotoxicity of aluminum has prompted the development of new methods for the determination of Al at trace and ultra-trace levels. A method was developed to determine trace amounts of Al in aqueous samples by ion chromatography using ammonium sulfate/nitric acid as eluent and pyrocatechol violet (PCV) as post-column chromogenic reagent. A Dionex 2010i ion chromatographic system equipped with a spectrophotometric detector was employed. To avoid sample contamination and minimize sample losses during injection, a pneumatic injection system was used. The detection limit for a 50 microliter sample was 10 micrograms/L. Preconcentration of the sample (obtained by replacing the sampling loop with a short ion-exchange column) allows larger amounts of sample to be loaded and lowers the detection limit below 1 microgram/L. Many metal complexes with PCV give a measurable absorbance in the present detection system; however, under given chromatographic conditions the retention times for these interfering species are all lower than that of Al(III). Using the proposed procedure only the total monomeric and labile polymeric species of Al can be determined; application of the method to natural waters in which inert polymeric Al may be present will be the subject of further work. (VerNooy-PTT)
W91-05333

SIMPLE BIOASSAY FOR THE DIAGNOSIS OF ALUMINIUM TOXICITY IN SOILS.
Queensland Dept. of Primary Industries, Indooroopilly (Australia). Agricultural Chemistry Branch.
R. L. Aitken, P. W. Moody, and B. L. Compton.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 7/8, p 511-529, 1990. 2 fig, 2 tab, 22 ref.

Descriptors: *Pollutant identification, *Acid rain effects, *Toxicity, *Aluminum, *Soil contamination, *Bioassay, *Plant growth, Root development, Soil tests, Sublethal effects, Soil solution, Roots, Seedlings.

A bioassay procedure was developed for diagnosing Al toxicity in soils using short term root growth in extracted soil solution. Soil solution is extracted from moist soil which has been incubated at 'field capacity' for 4 days. Soil solution extracted is divided into two portions, each of which is treated with calcium chloride and boric acid to ensure that neither calcium nor boron is limiting root growth. One portion is adjusted to pH 5.5 (pH adjusted treatment) with saturated Ca(OH)2 solution. Aliquots (11 mL) of each portion are separately dispensed into each of five polypropylene tubes. Seedlings (in this case Glycine max cv. Forrest) of uniform root length are inserted into each tube and grown for 48 hours. The increase in root length during the 48 hour growth period (root elongation) in the unadjusted solutions is expressed as a percentage of that in the pH adjusted solutions to derive relative root elongation (RRE)--an index of Al toxicity. For 24 acidic surface soils, RRE using this soil solution bioassay was linearly correlated (R squared = 0.96) with RRE obtained from a soil bioassay (with unamended, calcium sulfate and calcium carbonate treatments). Calcium carbonate is commonly used to obtain an index of Al toxicity. The proposed procedure is less time consuming and tedious than the soil bioassay, and interpretation of the result is unambiguous. (Author's abstract)
W91-05340

DEVELOPMENT AND USE OF AN ELECTRICAL RESISTIVITY CONE FOR GROUNDWATER CONTAMINATION STUDIES.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
R. G. Campanella, and I. Weemees.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 557-567, October 1990. 9 fig, 1 tab, 21 ref.

Descriptors: *Instrumentation, *Measuring instruments, *Water quality, Monitoring, *Geophysical methods, Electrical properties, Groundwater pollution, *Soil contamination, *Groundwater quality, *Resistivity, Soil density probes, Field tests, British Columbia, Dissolved solids, Electrodes, Sand.

The evaluation of groundwater quality has become increasingly important as more industrial waste and solid domestic refuse come into contact with groundwater. One method of detecting contaminated groundwater is by noting the electrical resistivity of the contaminated soil. This method has been applied at the University of British Columbia by the development and use of a new resistivity cone (RCPTU). The resistivity cone consists of four circumferential surface electrodes contained in a separate module behind a 15 sq cm piezocone. The cone is capable of providing a continuous record of resistivity with depth. An initial laboratory testing program was carried out using a simplified probe design to ensure the feasibility of the project. On the basis of favorable laboratory results the module was constructed, calibrated in the laboratory, and then field-tested at three sites in the lower mainland of British Columbia. Field testing illustrated the capability of the RCPTU to produce a detailed profile of bulk resistivity which is representative of changes in the amount of total dissolved solids in the groundwater. It was noted that soil resistivity could be related to measured cone parameters in sandy soils. This shows that the state of soil with respect to porosity and amount of fines can influence the bulk resistivity. The RCPTU showed that changes in soil density caused by penetration do affect bulk soil resistivity measurements. Comparing the results of the inner and outer electrode measurements it can be concluded that two electrodes excited at 1000 Hz are adequate for resistivity measurements. The speed, economy, and reliability of the RCPTU make it ideal for many contaminant site investigations in unconsolidated soil. (Fish-PTT)
W91-05358

INTERFERENCE OF SOLUBLE SILICA IN THE DETERMINATION OF ORTHOPHOSPHATE-PHOSPHORUS.
Bologna Univ. (Italy). Inst. of Agricultural Chemistry.
C. Ciavatti, L. V. Antisari, and P. Sequi.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 761-764, Oct-Dec 1990. 3 fig, 2 tab, 18 ref.

Descriptors: *Analytical methods, *Chemical interference, *Orthophosphates, *Phosphates, *Pollutant identification, *Silica, *Water analysis, Colorimetry, Nonpoint pollution sources, Performance evaluation, Spectrophotometry, Water pollution sources.

Determination of P concentrations in dilute solutions is currently used to assess P loadings to fresh and marine waters from nonpoint sources. The methods most widely used are colorimetric and involve the formation of a blue molybdenum acid complex. Possible P overestimates from interferences are caused by the presence of silica, which also forms a blue complex. The commonly used methods of Murphy and Riley, Dick and Tabatabai, and the Italian 'Instituto di Ricerca Sulle Acque' (IRSA) were tested for possible interferences caused by Si/P ratios (1000-5000) similar to those reported to occur in soil solutions and in groundwaters. The three methods all overestimated P concentrations due to the presence of Si in the solutions, especially if the spectrophotometric readings were taken more than 10 min from the addition of reagents. The least interference occurred with the procedure of Murphy and Riley, which partially reduces the interference of the more slowly forming silicomolybdenum complex by taking readings exactly 10 min after the addition of reagents and inhibiting its formation with the addition of sulfuric acid. This method is therefore recommended. (Doyle-PTT)
W91-05407

METHOD FOR DETERMINING VOLATILE ORGANIC SOLVENTS IN CHALK PORE WATERS (SOUTHERN AND EASTERN ENGLAND) AND ITS RELEVANCE TO THE EVALUATION OF GROUNDWATER CONTAMINATION.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
A. R. Lawrence, P. J. Chilton, R. J. Barron, and W. M. Thomas.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 377-386, December 1990. 2 fig, 2 tab, 10 ref.

Descriptors: *England, *Groundwater pollution, *Interstitial water, *Limestone, *Organic solvents, *Pollutant identification, *Sampling, Aquifers, Chlorinated hydrocarbons, Gas chromatography, Path of pollutants, Sample preparation, Separation techniques.

Conventional methods of sampling groundwater in chalk aquifers sample the mobile water in the fissures only and not the non-mobile water held in the microporous matrix. However, the microporous matrix can play an important role in modifying groundwater quality by attenuating contaminant migration through diffusion exchange and, in the longer term, by acting as a reservoir for contaminant retention. A method for extracting and analyzing chalk pore waters for chlorinated solvents was developed. Chalk sub-samples were taken from a drill-core sample in a glass bottle containing distilled water and pentane. Each bottle was tightly sealed and shaken on a vortex mixer to release the pore water and to enhance extraction into the pentane. After the bottles were centrifuged to separate chalk as sediment a sample was removed from the liquid portion in the neck of the bottle and injected into the gas chromatography column. Chalk pore water-depth profiles at the site of a spillage of tetrachloroethene demonstrated that the immiscible phase of the solvent had migrated to depths of 50 m, producing solvent concentrations in the matrix pore waters of up to 40,000 micrograms/L. In addition, the pore water-depth profile indicated that the immiscible phase had ponded upon a less permeable horizon within the chalk aquifer at shallow depths. (Author's abstract)
W91-05417

BIOACCUMULATION OF MUTAGENS AND PROMUTAGENS IN FISH TAKEN FROM FOUR SITES IN NORTHEAST TENNESSEE.
East Tennessee State Univ., Johnson City. Dept. of Health Sciences.
R. D. Blevins, and C. D. Mohr.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 7, p 731-744, October 1989. 2 fig, 1 tab, 5 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Fish populations, *Mutagenicity, *Mutagens, *Path of pollutants, *Tennessee, *Water pollution effects, Bioassay, Boone Lake, Fish metabolism, Holston River, Mammalian microsome assay, Nolichuky River, Separation techniques, Toxicity, Watuga Lake.

The accumulation of mutagens and/or promutagens was investigated in fish using the Ames Salmonella/mammalian microsome assay. The fish were taken from four different collection sites in northeast Tennessee: Watuga Lake, Boone Lake, the Nolichucky River, and the Holston River. A gross autopsy was performed on each fish. This autopsy consisted of recording weight, length, age, sex, and the physical condition of the various fish organs. Each fish (whole body) was extracted using ultra-pure 2-propanol as the solvent. Extracts were then screened for mutagenicity using bacterial Salmonella typhimurum tester strains TA97, TA98, TA100, and TA102. Two fish extracts showed mutagenicity (i.e., mutagenicity ratio > 2.5): one from Boone Lake and the other from the Nolichucky River. These two sample extracts were retested at several doses. Results indicated that only the fish sample from the Nolichucky River displayed a dose response when using either strains TA97 or TA98 with microsomal activation. (Author's abstract)
W91-05462

NEW METHOD FOR DETERMINING CONCENTRATIONS OF ENDOD-S (PHYTOLACCA DODECANDRA) IN WATER DURING MOLLUSCICIDING.
Tulane Univ., New Orleans, LA. Dept. of Environmental Health Sciences.
For primary bibliographic entry see Field 7B.
W91-05468

WATER SAMPLE CONTAMINATION BY GLASS FIBER AND CELLULOSE FILTERS.
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
For primary bibliographic entry see Field 7B.
W91-05559

CHLORIDE ANALYSES OF SOIL LEACHATE USING THE TRAACS 800 ANALYZER.
Guelph Univ. (Ontario).
D. A. Tel, and C. Heseltine.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 13-16, p 1689-1693, 1990. 2 fig, 5 ref.

Descriptors: *Analytical techniques, *Chemical analysis, *Chlorides, *Instrumentation, *Leachates, *Measuring instruments, *Soil chemistry, *Water analysis, Clays, Colloids, Colorimetry, Sample preparation.

Chloride is often used as a tracer element in leaching studies in soils. In many cases the leachate contains colloidal clay and organic colored substances that interfere with the determination of chloride. The use of automatic colorimetry has become increasingly popular in recent years due to its high sensitivity and speed. The TRAACS 800 continuous flow Auto Analyzer is equipped with features which enable the analysis of a wide range of concentrations with a minimum of sample preparation. The system includes a dialyzer, which overcomes the interference problems associated with Cl(-) determination, a random access sampler and an auto-dilute function. Highly colored plant extracts were analyzed without interference. In this method, the sample is mixed with the color reagent and dialyzed into the reagent again. The color reagents consist of mercuric thiocyanate, methanol, nitric acid and ferric nitrate. The reaction depends on the liberation of thiocyanate ions from mercuric thiocyanate, by reaction with Cl(-) ions and the formation of un-ionized but soluble mercuric chloride. In the presence of ferric ion, the liberated thiocyanate ion forms highly colored ferric thiocyanate, the concentration of which is proportional to the original chloride concentration. It was concluded that the TRAACS 800 enables the rapid and reliable analysis of Cl(-) in soil, plant and water extracts. (Agostine-PTT)
W91-05560

EFFICIENCY OF METHANOL:WATER SOLUTIONS FOR METRIBUZIN EXTRACTION FROM SELECTED SOILS.
Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.
M. A. Locke, J. V. Pothuluri, T. B. Moorman, and S. S. Harper.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 17/18, p 2141-2152, 1990. 6 tab, 20 ref.

Descriptors: *Analytical techniques, *Metribuzin, *Pollutant identification, *Soil chemistry, *Soil contamination, *Triazine herbicides, *Water analysis, Chemical analysis, Laboratory methods, Loam, Pesticides.

Extraction efficiency for metribuzin (4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one) from soil was evaluated using four solutions of methanol:water at ratios of 1:1, 7:3, 4:1, and 1:0 v/v. Two concentrations of metribuzin (0.216 and 2.44 microgram/g soil, unlabeled and 14-C labelled metribuzin, respectively) were added to surface and subsurface samples of a Dundee silt loam soil. Although the differences in extraction efficiencies were slight due to differences in methanol:water ratios, the metribuzin recovery varied with soil depth. Less metribuzin was recovered from surface soil extracted with 1:1 and 1:0 methanol:water solutions when compared to 7:3 and 4:1 solutions (80 and 81% vs 89 and 88% recoveries, respectively). About equal quantities, 81 to 85%, were recovered from the subsurface soil. Three extraction shaking times (0.5 h followed by another 0.5 h; 4 h:4 h; and 24 h:24 h) were also evaluated using the 4:1 extractant. No recovery differences were observed between the 0.5 h and 4 h shaking times. However, significantly higher recoveries occurred in both the surface and subsurface soil with 24 h shaking. The efficiency of this method was also determined on Eustis loamy sand, Sharkey clay, and Dorovan muck soils of diverse physical and chemical properties. The 4:1 extracting solution consistently yielded among the highest metribuzin recovery (74 to 97%) from the four soil types, and two depths of a Dundee soil. (Author's abstract)
W91-05563

ELECTROPHILES AND ACUTE TOXICITY TO FISH.
Utrecht Rijksuniversiteit (Netherlands). Research Inst. of Toxicology.
For primary bibliographic entry see Field 5C.
W91-05566

MODIFIED MOST-PROBABLE-NUMBER TECHNIQUE FOR THE SPECIFIC DETERMINATION OF ESCHERICHIA COLI FROM ENVIRONMENTAL SAMPLES USING A FLUOROGENIC METHOD.
Malaga Univ. (Spain). Dept. of Microbiology.
M. C. Balebona, M. A. Morinigo, R. Cornax, J. J. Borrega, and M. Torregrossa.
Journal of Microbiological Methods JMIMDQ, Vol. 12, No. 3/4, p 235-245, 1990. 1 fig, 4 tab, 44 ref.

Descriptors: *Bacteria, *Bioindicators, *Escherichia coli, *Fluorometry, *Statistical methods, *Water analysis, Analysis of variance, Coliforms, Data interpretation, Laboratory methods, Mathematical studies, Microbiological studies, Water quality.

A specific and sensitive modification of the most-probable-number (MPN) technique was performed by the addition of 4-methylumbelliferyl-beta-D-glucuronide (MUG) to both presumptive and confirmatory media. The use of this modification allows of the precise determination of Escherichia coli from marine samples (seawater, sediment and shellfish) within 7 days, compared to 10-12 days required by using the standard methodology. This assay is based on the almost exclusive presence of the enzyme beta-glucuronidase in E. coli. The substrate MUG is broken down by the enzyme to release 4-methylumbelliferone, which is fluorescent under ultraviolet light (365 nm). No false-positive isolates for fluorescence reaction were observed, although one E. coli strain that was fluorescent positive on agar was isolated from non-fluorescent tubes. Klebsiella pneumoniae was the species most frequently detected from tubes with gas and fluorescence production and typical morphology on mFC agar, but failed on nutrient-MUG agar. Using a unifactorial variance analysis of the mean, fluorescence in tubes and on agar was determined to be the factor which allows the detection of E. coli in the three sample types with high accuracy. The incorporation of MUG to the selective broth in the confirmatory test has been shown to prevent false-positive results due to shellfish tissue beta-glucuronidase activity. Specificity of the MUG-MPN method was high (Se = 0.94 and Sp = 0.79). The results obtained using laboratory strains showed that although E. coli, Citrobacter freundii, Enterobacter cloacae and K. pneumoniae produce acid and gas in MacConkey-purple broth, beta-glucuronidase activity in this selective broth is specific to E. coli. (Author's abstract)
W91-05572

CROSS-FLOW FILTRATION OF COLLOIDS FROM AQUATIC ENVIRONMENTS.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
B. G. Whitehouse.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1368-1375, September 1990. 3 fig, 3 tab, 11 ref. Department of Supply and Services (Canada) Contract 09SC.FP901-5-A514.

Descriptors: *Colloids, *Filtration, *Laboratory methods, *Pollutant identification, *Ultrafiltration, *Water analysis, Contamination, Mass balance, Organic matter, Trace metals.

In recognition of problems associated with traditional ultrafiltration techniques, cross-flow ultrafiltration has been adapted to isolate colloidal material from natural aquatic environments, both freshwater and marine. The procedure is capable of delivering filtration rates on the order of tens of liters per hour without introducing significant quantities of organic or trace-metal contaminants, and thus is suitable for large-volume and trace-component applications. Mass balance experiments in which concentrations were measured in ultrafiltrate and retained fractions show that both organic material and several trace metals are recovered without significant losses on the filters. (Author's abstract)
W91-05585

USE OF A REMOTE OPERATED VEHICLE (ROV) TO EVALUATE MARINE DISCHARGES OF TREATED WASTEWATER.
Metcalf and Eddy, Inc., Wakefield, MA.
For primary bibliographic entry see Field 7B.
W91-05663

ISOLATION OF BACTERIOPHAGES FROM LARGE VOLUMES OF PRISTINE TROPICAL WATERS AND THEIR CORRELATION TO FECAL CONTAMINATION.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
E. A. Hernandez Delgado, and G. A. Toranzos.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 543-551, 1 fig, 3 tab, 21 ref.

Descriptors: *Bacteriophage, *Bioindicators, *Fecal coliforms, *Pollutant identification, *Tropical hydrology, *Tropical regions, *Viruses, *Water quality, Bacteria, Coliforms, Laboratory methods, Microbiological studies, Monitoring, Streptococcus.

Recently, strong evidence has been found against the use of coliforms as indicator organisms of fecal contamination in tropical waters. False positive and false negative results are commonly found. There is a need for the development of more rapid low-cost techniques for determining microbiological water quality. A method has been developed to analyze large volumes of pristine tropical waters for the presence of coliphages. It involves the filtration of water through positively charged filters and an elution step. The eluent is then mixed with nutrient agar and incubated. Water samples were analyzed from a rain forest, ranging from pristine river waters and water collected from bromeliads (epiphytic vegetation), to recreational rivers. Total and fecal coliforms as well as fecal streptococci levels detected were higher than recommended standards for fecal contamination of waters. Bacteriophages have been detected only in recreational waters, but not from bromeliads or pristine waters. These data suggest a correlation between the presence of phages and fecal contamination. (See also W91-05611) (Author's abstract)
W91-05666

DETERMINATION OF 1 NG/L. LEVELS OF MERCURY IN WATER BY ELECTROTHERMAL ATOMIZATION ATOMIC-ABSORPTION SPECTROMETRY AFTER SOLVENT EXTRACTION.

Universite de Bretagne-Occidentale, Brest (France).
A. Le Bihan, and J. Y. Cabon.
Talanta TLNTA2, Vol. 37, No. 12, p 1119-1122, December 1990. 1 fig, 1 tab, 19 ref.

Descriptors: *Atomic absorption spectrophotometry, *Chemical analysis, *Laboratory methods, *Mercury, *Pollutant identification, Detection limits, Sensitivity analysis, Solvents, Water chemistry.

The sensitivity of current methods of trace determination of mercury is high but not sufficient for the direct determination of mercury in unpolluted natural waters. To measure such low levels a procedure is proposed for determination of mercury in the ng/L range with sample volumes around 100 ml, by use of only conventional electrothermal atomic absorption spectrometers. To reduce the risk of mercury losses (or gains by contamination) the metal is determined in the solvent used for the extraction, which is performed directly in the sampling vessel. The determination of mercury in water, at the 1 ng/L level, requires optimization of the experimental conditions for both the atomic absorption spectrophotometry and the extraction. A low characteristic mass was achieved by integration of the signal and by choosing an atomization temperature close to 700 degrees; in such conditions the characteristic mass is 20 pg in aqueous solution and 30 pg in chloroform extracts (with Zeeman correction). When the extraction with sodium diethyldithiocarbamate was performed directly in the sampling vessel at a sample-to-solvent volume ratio of 100 (100 ml sample, 400 microliters extract), the characteristic concentration was better than 1 ng/L (0.8 ng/L), with a 30% relative standard deviation. Besides high sensitivity, advantages of the procedure include time saving and a reduced risk of contamination with, or loss of, mercury. (Fish-PTT)
W91-05800

MAPPING ZONES OF CONTAMINATED GROUND-WATER DISCHARGE USING CREEK-BOTTOM-SEDIMENT VAPOR SAMPLERS, ABERDEEN PROVING GROUND, MARYLAND.

Geological Survey, Columbia, SC.
For primary bibliographic entry see Field 5B.
W91-05813

'WHERE'S THE BENZENE': EXAMINING CALIFORNIA GROUND-WATER QUALITY SURVEYS.

Applied Science and Engineering, Inc., Davis, CA.
For primary bibliographic entry see Field 5B.
W91-05818

USE OF ATOMIC ABSORPTION SPECTROSCOPY WITH A GRAPHITE FURNACE TO DETERMINE ARSENIC IN NATURAL WATERS AND AQUEOUS SOIL EXTRACTS.

Z. N. Kakhnovich, and L. A. Lerner.
Soviet Soil Science SSSCAE, Vol. 21, No. 2, p 113-118, 1989. 2 fig, 5 tab, 3 ref. Translated from: Pochvovedeniye, No. 10, p 127-131, 1988.

Descriptors: *Arsenic, *Chemical analysis, *Pollutant identification, *Spectroscopy, *Water analysis, Atomic adsorption spectroscopy, Graphite furnace, Laboratory methods, Performance evaluation.

An electrothermal atomic absorption method of determining arsenic in natural waters and aqueous soil extracts using a graphite furnace was developed. The effects of HCl, HNO3, Na, K, Ca, Mg, Al, Fe, Si, and P and the effect of the type of graphite surface on the arsenic absorbing capacity A(As) was investigated. Nickel sulfate (NiSO4) at 1 mg/l is recommended as a modifier to eliminate the effect of extraneous elements on A(As). The use of NiSO4 also makes in possible to raise the temperature of the thermolysis stage to 1500 C. Arsenic is determined in a standard graphite furnace in the presence of NiSO4 using two-stage thermolysis. The validity of the method was tested by the 'added and found' technique and by comparing the analyses of state standard samples with their certified concentrations. The detection limit for arsenic was 0.005 microgram/ml. The coefficient of variation was 3.4%. (Rochester-PTT)
W91-05829

ELECTROPHILES AND ACUTE TOXICITY TO FISH.

Utrecht Rijksuniversiteit (Netherlands). Research Inst. of Toxicology.
For primary bibliographic entry see Field 5C.
W91-05891

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF STANDARD REFERENCE MATERIAL 1941, ORGANICS IN MARINE SEDIMENT.

National Inst. of Standards and Technology (NML), Gaithersburg, MD. Center for Analytical Chemistry.
S. F. Stone, B. J. Koster, and R. Zeisler.
Biological Trace Element Research BTERDG, Vol. 26/2, p 579-586, July/December 1990, 1 fig, 1 tab, 13 ref.

Descriptors: *Marine sediments, *Neutron activation analysis, *Organic pollutants, *Pollutant identification, *Sediment analysis, *Standards, Analytical methods, Laboratory methods, Marine pollution, Organic compounds, Sediment contamination, Trace elements.

The National Institute of Standards and Technology has developed a new Standard Reference Material 1941, 'Organics in Marine Sediment.' In addition to the organic constituents, consisting of 11 polycyclic aromatic hydrocarbons, 15 PCB congeners, and seven chlorinated pesticides, over 30 elements have been determined by instrumental neutron activation analysis and prompt-gamma activation analysis. The homogeneity of the material was investigated and relative standard deviations of single-element concentrations in the 250 mg samples were found to be 1% or less with regard to major inorganic constituents and rare earth elements. A slightly higher relative SD was found for elements that may stem from biological or anthroprogenic input. The element concentrations determined in this work were compared for content and homogeneity with IAEA-SD-N-1/2 a similar reference material used as a control. Concentrations for 31 elements will be included for information on the certificate. (Doyle-PTT)
W91-05900

MICRONUCLEUS TEST IN FISH FOR MONITORING THE GENOTOXIC EFFECTS OF INDUSTRIAL WASTE PRODUCTS IN THE BALTIC SEA, SWEDEN.

Institut Jozef Stefan, Ljubljana (Yugoslavia).
K. Al-Sabti, and J. Hardig.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 97, No. 1, p 179-182, 1990. 2 fig, 1 tab, 21 ref.

Descriptors: *Baltic Sea, *Bioindicators, *Industrial wastewater, *Monitoring, *Pulp and paper industry, *Sweden, *Toxicity, *Wastewater pollution, *Water pollution effects, Erythrocytes, Field tests, Genotoxicity, Micronuclei.

Biological testing is a scientifically valid approach to control toxic substances in industrial wastewater discharges. Therefore, the feasibility of using micronuclei induction in fish as an indicator of genotoxics under actual field conditions was investigated. The micronucleus test provides estimates of the frequencies of mutational damage, and gives insight into the direct and/or indirect risk to human health of environmental pollutants. The test is based on the fact that the consequences of unrepaired mutations are expressed by the frequency of micronuclei. Perch were collected from the Baltic Sea in the vicinity of a pulp plant in Sweden, and their blood cells examined for micronuclei. A single micronucleus was predominant in the perch erythrocyte cells, and this was found in about 95% of all counted micronucleated erythrocyte cells, while about 5% were with two micronuclei. A discharge distance-relationship was found. Fish specimens found in the Baltic seawater contaminated by pulp wastewater products had increased levels of micronuclei frequency in the erythrocytes, which was a function of distance from the discharge points. These results indicate that the frequency of micronuclei in fish can serve as a relevant parameter in the assessment of genotoxic pollutants. Micronuclei measurements in fish were shown to be a better parameter than chromosomal aberrations in environmental studies under laboratory and field conditions. (White-Reimer-PTT)
W91-05944

CHARACTERIZATION OF THE H4IIE RAT HEPATOMA CELL BIOASSAY AS A TOOL FOR ASSESSING TOXIC POTENCY OF PLANAR HALOGENATED HYDROCARBONS IN ENVIRONMENTAL SAMPLES.

Michigan State Univ., East Lansing. Pesticide Research Center.
D. E. Tillitt, J. P. Giesy, and G. T. Ankley.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 87-92, January 1991. 4 fig, 3 tab, 52 ref.

Descriptors: *Bioassay, *Chemical analysis, *Halogenated hydrocarbons, *Hydrocarbons, *Pollutant identification, *Toxicity, Polychlorinated biphenyls, Polychlorinated dibenzofurans, Testing procedures, Tissue analysis.

Planar halogenated hydrocarbons (PHHs) are a group of chemicals with isosteric configurations or structures and include, among other environmental contaminants, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs). An in vitro system, the H4IIE rat hepatoma cell bioassay, was characterized for use in assessing the overall toxic potency of PCBs, PCDDs, and PCDFs in extracts from environmental samples. This in vitro bioassay of cytochrome P450A11 catalytic activity in the H4IIE cells in response to PHHs was repeatable over time and standards were reproducible among laboratories when dosing conditions were similar. Three common extraction/cleanup procedures tested had no adverse effect on the response of the cells and biogenic interferences were not encountered. Comparison of the response of the H4IIE cells to extracts was calibrated against their response to the standard, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) to give TCDD equivalents (TCDD-EQ).

This method of calibration proved to be effective for quantitation of known amounts of PHHs spiked into a sample matrix. The bioassay was applied to fish and wildlife samples (Chinook salmon, aquatic bird eggs) taken from the Great Lakes. The TCDD-EQ in picog/g ranged from 26.7 in Chinook salmon to 415.7 in Caspian tern eggs. The potential utility of this bioassay is as an integrative tool to assess the toxic potency of complex mixtures of PHHs. The results of this bioassay can complement chemical residue analysis and direct the need for such analysis, as well as aid in the interpretation of biological effects data from environmental studies. (Author's abstract)
W91-05950

APPLICATION OF THE MASTER ANALYTICAL SCHEME TO THE DETERMINATION OF VOLATILE ORGANICS IN WASTEWATER INFLUENTS AND EFFLUENTS.
Research Triangle Inst., Research Triangle Park, NC.
L. C. Michael, E. D. Pellizzari, and D. L. Norwood.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 150-155, January 1991. 3 fig, 4 tab, 3 ref. EPA Contract 68a-01-6904.

Descriptors: *Pollutant identification, *Testing procedures, *Volatile organic compounds, *Wastewater analysis, *Wastewater pollution, *Water pollution sources, Halogens, Laboratory methods, Wastewater treatment, Water analysis.

Volatile organic compounds were isolated, identified, and quantitated in wastewater influents and effluents by using the EPA Master Analytical Scheme (MAS), a set of protocols developed to determine a broad spectrum of organic pollutants from a wide variety of chemical classes. The MAS volatile organics protocol is designed to measure purgeable organic compounds in wastewaters, as well as other types of water. These analyses were performed as part of a U.S. EPA assessment of water quality in the Great Lakes basin. In addition to 50 target compounds, up to 55 nontarget (unknown) compounds were identified and quantitated in 20 samples obtained from public-owned treatment works. This analytical approach showed clear reductions between influents and effluents, in the number of compounds identified, the total concentration of halogenated and nonhalogenated compounds, and the concentration of the largest component. Reductions in the number of target compounds detected in influents vs effluents were relatively small in proportion to reductions in the total amounts of halogenated and nonhalogenated compounds. Overall, reductions in nontarget compounds, before and after treatment, were comparable to reductions in target compounds in terms of both number and total concentration. (Author's abstract)
W91-05955

DETECTION OF POLY(ETHYLENE GLYCOL) RESIDUES FROM NONIONIC SURFACTANTS IN SURFACE WATER BY 1H AND 13C NUCLEAR MAGNETIC RESONANCE SPECTROMETRY.
Geological Survey, Denver, CO.
J. A. Leenheer, R. L. Wershaw, P. A. Brown, and T. I. Noyes.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 161-168, January 1991. 7 fig, 2 tab, 22 ref.

Descriptors: *Colorimetry, *Mississippi River, *Pollutant identification, *Polyethylene glycol, *Spectrometry, *Surfactants, Colorado, Fulvic acids, Laboratory methods, Organic pollutants, Surface water.

Poly(ethylene glycol) (PEG) residues were detected in organic solute isolates from surface water by 1H nuclear magnetic resonance spectrometry (NMR), 13C NMR spectrometry, and colorimetric assay. PEG residues were separated from natural organic solutes in Clear Creek, CO, by a combination of methylation and chromatographic procedures. The isolated PEG residues, characterized by NMR spectrometry, were found to consist of neutral and acidic residues that also contained poly(propylene glycol) moieties. The 1H NMR and the colorimetric assays for poly(ethylene glycol) residues were done on samples collected in the lower Mississippi River and tributaries between St. Louis, MO, and New Orleans, LA, in July-August and November-December 1987. Aqueous concentrations for poly(ethylene glycol) residues based on colorimetric assay ranged from undetectable to about 28 microg/L. Concentrations based on 1H NMR spectrometry ranged from undetectable to 145 microg/L. The most specific technique was 13C NMR spectrometry, which allows one to distinguish poly(ethylene glycols) from poly(propylene glycols) in the presence of natural organic solutes. 1H NMR spectrometry has adequate sensitivity for environmental monitoring, but it lacks the resolution to distinguish various end groups and poly(propylene glycol) content in PEG residues in the presence of fulvic acid. The NMR and colorimetric assays of organic solutes from both rivers indicate that PEG residues are ubiquitous contaminants in these waters during both summer and winter. The 1H NMR assay found 4-15 times the PEG residue concentrations in the lower Mississippi River than was determined by colorimetric assay of these samples. The concentrations of PEG residues found in Clear Creek and in the lower Mississippi river make these residues one of the most abundant contaminant classes found in these surface waters. (White-Reimer-PTT)
W91-05956

5B. Sources Of Pollution

ROLE OF THE CEMENT INDUSTRY IN THE CONTAMINATION OF AIR, WATER, SOIL AND PLANT WITH VANADIUM IN CAIRO.
National Research Centre, Cairo (Egypt). Air Pollution Dept.
K. T. Hindy, H. I. Shafy, and S. A. Farag.
Environmental Pollution ENPOEK, Vol. 66, No. 3, p 195-205, 1990. 2 fig, 4 tab, 22 ref.

Descriptors: *Air pollution sources, *Cairo, *Cement industry, *Egypt, *Vanadium, *Water pollution sources, Plant contamination, Soil contamination.

Levels of vanadium in air, water, soil and plants resulting from the operation of a cement factory were studied over a twelve-month period. Samples of air solids, dry deposition, water, soil and plants around the cement factory, as well as the raw materials used in the cement production were sampled on a monthly basis. Results obtained were compared with the level of vanadium in a relatively non-polluted residential area. The cement factory is the main source of the element in the adjacent environment, being responsible for more than 70% of the vanadium in dry deposition. The levels of vanadium in the El-Khashab canal, soil, and Eichhornia crassipes were highest at the site nearest the cement factory and showed a gradual decrease with increasing distance from the factory. This is due to the fact that the cement factory is using fossil fuels and raw materials both of which contain high levels of vanadium without adequate control of the release of pollutants. Continuous release of air-borne dust from the cement industry will increase the level of vanadium in the surrounding environment in the long run. (Feder-PTT)
W91-04941

INFLUENCE OF MODE OF EXPOSURE AND THE PRESENCE OF A TUBICULOUS POLYCHAETE ON THE FATE OF BENZ(A)ANTHRACENE IN THE BENTHOS.
Woods Hole Oceanographic Institution, MA.
A. E. McElroy, J. W. Farrington, and J. M. Teal.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1648-1655, November 1990. 4 fig, 3 tab, 41 ref. NOAA contract 83-ABD-00012.

Descriptors: *Benthos, *Microbial degradation, *Polychaetes, *Polycyclic aromatic hydrocarbons, Biological oxidation, Boston Harbor, Sediment contamination.

The distribution and metabolism of benz(a)anthracene (BA) was followed in benthic microcosms in the presence and absence of the polycheate Nereis virens for periods of 4-25 days to assess simultaneously the effects of mode of introduction and the presence of large burrowing organisms on the fate of polycyclic aromatic hydrocarbons and their metabolites in the benthos. Radiolabeled BA was added to the chambers in three ways: already sorbed to the entire sediment reservoir, directly into the water column, or incorporated into food for the worms. BA added to the water column was more available for uptake and metabolism by worms and microbial mineralization to carbon dioxide than BA previously sorbed to the entire sediment reservoir. In experiments with the sediment reservoir uniformly labeled with BA, worms increased flux of BA from the sediment, and with time, their presence led to increased rates of microbial mineralization of BA to carbon dioxide. Dietary BA was most rapidly metabolized by Nereis. (Author's abstract)
W91-04945

INFLUENCE OF ORGANIC MATTER FROM SOILS AND SEDIMENTS FROM VARIOUS ORIGINS ON THE SORPTION OF SOME CHLORINATED ALIPHATIC HYDROCARBONS: IMPLICATIONS ON K(OC) CORRELATIONS.
Tuebingen Univ. (Germany, F.R.). Inst. fuer Geologie und Palaentologie.
P. Grathwohl.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1687-1693, November 1990. 5 fig, 5 tab, 36 ref.

Descriptors: *Chlorinated hydrocarbons, *Fate of pollutants, *Organic matter, *Path of pollutants, *Sediment contamination, *Soil contamination, *Sorption, Sediment chemistry, Soil chemistry.

Soprtion of nonionic compounds is strongly dependent on the content as well as the nature of the organic matter in soils and sediments. The composition and the structure of organic matter varies due to its origin and geological history and strongly influences the sorption affinity for nonionic organic compounds. Organic matter in unweathered shales and high-grade coals shows enhanced sorption compared to organic matter in recent soils or geologically young material and low-grade coals. The results obtained indicate a decrease in sorption with increasing proportions of oxygen-containing functional groups in natural organic substances. A first approximation to estimate sorption coefficients for various organic matter is provided by an empirical correlation between the hydrogen/oxygen atomic ratio as an index of the oxidation of the organic matter and the organic carbon normalized sorption coefficients (Koc). This approximation also permits adjustment of Koc values derived from the respective octanol-water partition coefficients. (Author's abstract)
W91-04948

ORGANIC CONTAMINANTS IN AN AGRICULTURAL SOIL WITH A KNOWN HISTORY OF SEWAGE SLUDGE AMENDMENTS: POLYNUCLEAR AROMATIC HYDROCARBONS.
Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.
For primary bibliographic entry see Field 5E.
W91-04949

AIRBORNE MERCURY DEPOSITION AND WATERSHED CHARACTERISTICS IN RELATION TO MERCURY CONCENTRATIONS IN WATER, SEDIMENTS, PLANKTON AND FISH OF EIGHTY NORTHERN MINNESOTA LAKES.
Minnesota Univ., Duluth. Coll. of Science and Engineering.
J. A. Sorensen, G. E. Glass, K. W. Schmidt, J. K. Huber, and G. R. Rapp.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1716-1727, November 1990. 5 fig, 6 tab, 50 ref.

Descriptors: *Air pollution effects, *Lakes, *Mercury, *Minnesota, *Water analysis, *Water pollution sources, Pike, Sediment analysis, Sediment contamination, Water sampling, Watershed models, Zooplankton.

Mercury concentrations in precipitation, lake water and sediment, zooplankton and fish were measured and analyzed together with extensive watershed and lake chemistry data for eighty lake watersheds in the study region of northeastern Minnesota. The annual average volume-weighted mercury concentrations were measured in precipitation for 1988 at Mercell, Ely and Duluth, MN and found to be 18, 19 and 22 ng of Hg/L, respectively. The calculated yearly wet depositional loadings for lakes across the study region ranged from 10 to 15 micrograms of Hg/sq m. Mercury levels in surface water ranged from <2 to 7 ng of Hg/L and averaged 2.5 ng of Hg/L with 40 % of the lakes being consistently below the detection limit. Mercury levels in surface sediment on a dry weight basis ranged from 34 to 331 ng of Hg/g with an average of 160 Hg/n. Mercury levels of zooplankton on a dry weight basis ranged from 9 to 200 ng of Hg/g with an average of 88 ng of Hg/g. The mercury level in northern pike for these lakes averaged 450 ng of Hg/g and ranged from 140 to 1500 ng of Hg/g. The primary source of mercury was found to be of atmospheric origin. (Feder-PTT)
W91-04951

NOVEL CHLORINATED TERPHENYLS IN SEDIMENTS AND SHELLFISH OF AN ESTUARINE ENVIRONMENT.
Virginia Inst. of Marine Science, Gloucester Point.
R. C. Hale, J. Greaves, K. Gallagher, and G. G. Vadas.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1727-1731, November 1990. 3 fig, 1 tab, 23 ref.

Descriptors: *Estuarine sediments, *Halogenated compounds, *Oysters, *Polychlorinated terphenyls, *Sediment analysis, Aroclors, Back River, Estuarine environment, Gas chromatography, Virginia.

Polychlorinated terphenyls (PCTs) are structurally similar to polychlorinated biphenyls (PCBs) and have been used in analogous applications. Aroclor 5432, a PCT formulation whose congeners contain predominantly two to five chlorines, was detected in sediments and oysters from a saltmarsh creek and an adjacent Chesapeake Bay tributary, Back River. Capillary gas chromatography with electrolytic conductivity detection was used for quantitation. Identifications were confirmed by both electron ionization and negative chemical ionization mass spectrometry. Sediment concentrations detected were as high as 250,000 microgram/kg(dry-weight basis). Oysters collected from these areas contained up to 35,000 microgram/kg. This value exceeds the applicable United States limit for PCBs in edible shellfish by more than a factor of three. (Author's abstract)
W91-04952

EVIDENCE OF SENSITIZED PHOTOLYSIS OF POLYCHLORINATED DIBENZO-P-DIOXINS IN NATURAL WATERS UNDER SUNLIGHT CONDITIONS.
Manitoba Univ., Winnipeg. Pesticide Research Lab.
K. J. Friesen, D. C. G. Muir, and G. R. Webster.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1739-1744, November 1990. 4 fig, 3 tab, 37 ref. Canadian Wildlife Service contract OSU-82-00277; Natural Sciences and Engineering Research Council of Canada Grant G1505.

Descriptors: *Dioxins, *Fate of pollutants, *Natural waters, *Photolysis, Distilled water, Laboratory methods, Water analysis.

The sunlight photolysis of carbon-14 labeled 1,2,,,3,4,7-pentachlorodibenzo-p-dioxin(P5CDD) and 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin(H2CDD) was studied at 50 degrees N latitude in filter-sterilized natural water and in distilled water-acetronitrile(2:3, v/v) solutions to determine the extent of direct versus indirect photolysis under environmental conditions. Under midsummer sunlight conditions, pseudo-first-order sunlight photolysis rate constants of 0.74 and 0.28 day(-1) were measured for P(5)CDD and H(7)CDD in natural water. However, slower direct aqueous photolysis rates were observed for the two PCDD congeners in distilled water-acetronitrile, with rate constants of 0.058 and 0.019 day(-1) for P(5)CDD and H(7)CDD, in relatively food agreement with predicted rates of direct aqueous photolysis. The results indicate that an indirect or sensitized photolytic mechanism may dominate the photodegradation of PCDDs in natural waters. The major degradation products appeared as nonextractable (14)C activity, with increases in this fraction paralelling the disappearance of the parent PCDD. (Author's abstract)
W91-04954

MONITORING THE TOXICITY OF ORGANIC COMPOUNDS DISSOLVED IN RHINE WATER.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Ecotoxicology, Environmental Chemistry and Drinking Water.
D. De Zwart, and A. Folkerts.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 5-12, July 1990. 5 fig, 14 ref.

Descriptors: *Bioassay, *Organic compounds, *Path of pollutants, *Rhine River, *Toxicity, *Water pollution effects, *Water quality, Absorption, Bacteria, Laboratory methods, Microbiological studies, Monitoring, The Netherlands.

Organic concentrates from Rhine River water were tested for toxicity with a 15 minute test (MICROTOX) on luminescent bacteria (Photobacterium phosphoreum, Bacteria). A total number of 18 stations in the Dutch lower Rhine area were sampled 5 times at monthly intervals (April 1988-August 1988), whereas two stations located the furthest apart (Lobith and Maassluis) were sampled at two week intervals between January and October. The river samples were concentrated by neutral absorption on XAD resins, followed by elution with acetone. Toxicity is expressed on a relative scale within a range of approximately 3 to 18, which indicates that the organic toxics present in the Rhine water had to be concentrated between 55 and 330 fold. During transport in The Netherlands, the dissolved organic toxicity contained in the water of the Rhine River decreased gradually, either as a consequence of degradation or by adsorption to newly formed particulates. In the industrialized areas of the lower Rhine in The Netherlands, a slight but temporary increase in toxicity is observed. Since water quality improved greatly with respect to inorganic (heavy metal) pollution, the organic toxicity reflects the actual pollution status more closely than in the past. The speed and simplicity of the combination of XAD concentration and MICROTOX toxicity determination enables large-scale monitoring studies on organic toxins in moderately polluted water. (Author's abstract)
W91-04957

KINETICS OF THE DEGRADATION OF CHLOROFORM AND BENZENE IN ANAEROBIC SEDIMENT FROM THE RIVER RHINE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
P. Van Beelen, and F. Van Keulen.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 13-21, July 1990. 11 fig, 14 ref.

Descriptors: *Benzene, *Biodegradation, *Chloroform, *Fate of pollutants, *Kinetics, *Path of pollutants, *Rhine River, *Sediments, Anaerobic bacteria, Bacteria, Carbon dioxide, Carbon radioisotopes, Degradation, Mathematical studies, Radioactive half-life.

In anaerobic methanogenic sediment microcosms 14-C labeled chloroform was degraded mainly to CO2. At a concentration of 4 microg/L, the mineralization followed first order kinetics with a half-life of 12 days at 10 C, and 2.6 days at 20 C. At a concentration of 400 microg/L the mineralization time increased with time and followed logarithmic kinetics with a micro max (maximal growth rate of bacteria, which is dependent on temperature) of 0.02/d at 10 C. The logarithmic kinetics can be explained by growth of the bacteria on the higher concentration of chloroform with a generation time of 35 days. Shaking and oxygenation did not inhibit the mineralization of chloroform, probably because of bacterial consumption of the dissolved oxygen. Carbon-14 labeled benzene was mineralized only for a small percentage to 14-C labeled CO2 while other, not acid extractable, degradation products were formed. Under anaerobic conditions 5% of the benzene was degraded to CO2 after just one day, and the mineralization ceased while the disappearance of benzene proceeded. With air in the head space of the incubation bottles, 25% of the benzene was mineralized to CO2. The anaerobic degradation of benzene at a concentration of 100 microg/L showed similar kinetics to the degradation at 1 microg/L. Hence, no adaptation of the microflora in the sediment occurred during the 63 days of the experiment at 100 microg/L. (Author's abstract)
W91-04958

SOURCES OF PETROLEUM HYDROCARBONS IN URBAN RUNOFF.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
J. S. Latimer, E. J. Hoffman, G. Hoffman, J. L. Fasching, and J. G. Quinn.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 1-21, 1990. 5 fig, 5 tab, 30 ref. NOAA Office of Marine Pollution Assessment Grant No. NA80RAD00047.

Descriptors: *Hydrocarbons, *Oil pollution, *Trace metals, *Urban runoff, *Water pollution sources, Aromatic compounds, Cadmium, Copper, Iron, Land use, Lead, Manganese, Path of pollutants, Zinc.

Petroleum products as well as probable source materials were analyzed for hydrocarbons and trace metals and then compared to urban runoff samples from four different land use areas. The petroleum products considered were No. 2 and No. 6 fuel oils, used and virgin crankcase oils, and gasoline. Source materials included street dust, roadside soil, roadside vegetation, and atmospheric fallout; and the land use categories were commercial, residential, interstate highway, and industrial areas. The samples were compared on the basis of hydrocarbons (saturated and aromatic), and trace metal (Cd, Pb, Mn, Cu, Fe, Zn) loadings and distributions. Results indicated that the hydrocarbon content in runoff at all four land use sites originated primarily from used crankcase oil, will a small amount of No. 2 fuel oil detected at the industrial site. Only a small portion of the crankcase oil component came from the sources surveyed, and the majority of this oil probably came from: (1) oil drops within the driving lanes on the road surfaces or deposits in parking areas, and/or (2) direct dumping of waste crankcase oil down storm drains. (Author's abstract)
W91-04967

ELEMENTAL CONCENTRATIONS IN FISHES FROM THE SALTON SEA, SOUTHEASTERN CALIFORNIA.
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
M. K. Saiki.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 41-56, 1990. 1 fig, 4 tab, 27 ref.

Descriptors: *Bioaccumulation, *Drainage water, *Fish, *Irrigation effects, *Path of pollutants, *Saline lakes, *Salton Sea, *Selenium, Arsenic, Boron, California, Cobalt, Copper, Ecotoxicology, Iron, Lead, Mercury, Molybdenum, Nickel, Public health, Tissue analysis, Trace metals, Vanadium, Water pollution effects, Water pollution sources, Zinc.

The Salton Sea is a 93,000 ha saline lake fed by drainage water from more than 283000 ha of irrigated lands in the Imperial and Coachella valleys of California. A total of 21 composite samples of 4 recreationally important fish species--bairdiella (Bairdiella icistia), orangemouth corvina (Cynoscion xanthulus), sargo (Aniostremus davidsoni), and Mozambique tilapia (Tilapia mossambica)--collected there were analyzed for 14 elements. Twelve of these elements were detected in one or more of the samples: As, B, Co, Cu, Fe, Hg, Mo, Ni, Pb, Se, V, and Zn. Cadmium and Tl were not detected. The ranges in concentrations in elements in the skinless filets of bairdiella, corvina, and sargo, and in whole bodies of all four fishes were comparable to levels that are typically measured in saltwater fishes. Only Se concentrations were elevated (as much as 14 micro g/g dry weight in both filets and whole bodies) in this series of samples. Elevated concentrations of Se have already led to public health advisories concerning the consumption of fish and might eventually cause the demise of fish populations from toxic effects. (Author's abstract)
W91-04968

CONCENTRATION AND PARTIONING OF PARTICULATE TRACE METALS IN THE CHANGJIANG (YANGTZE RIVER).
Department of Marine Chemistry, Ocean Univ. of Qingdao, 5 Yushan Road, Qingdao 266003, P.R. China.
J. Zhang, W. W. Huang, and Q. Wang.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 57-70, 1990. 3 fig, 4 tab, 45 ref.

Descriptors: *Changjiang River, *Suspended sediments, *Trace metals, *Water chemistry, *Water pollution sources, Cadmium, Chemical analysis, China, Chromium, Copper, Erosion, Heavy metals, Huang He River, Lead, Nickel, Sediment chemistry, Weathering.

Suspended sediments from the lower Changjiang (Yangtze River) were sampled to determine concentrations of Cu, Cd, Pb, Ni, and Cr. The particulate trace element values in the Changjiang are higher than in the Huanghe (Yellow River) but lower than other large Chinese rivers (e.g. Pearl River) and polluted rivers. A general pattern of high element levels in the clay minerals and low element concentrations in coarse sediment fractions are observed in the Changjiang. Sequential extraction shows the predominance of metals in the residual fraction relative to labile fractions in the Changjiang, emphasizing the importance of natural weathering and erosion in the drainage basin on the transport of particulate metals. Evaluated Enrichment Factors (EF: the ratio of elemental concentration in microsurface to that in subsurface layer minus 1.0) suggest a potential influence of atmospheric input on the concentrations of particulate metals in the river. (Author's abstract)
W91-04969

ROLE OF WEATHERING AND FORESTRY IN DETERMINING THE ACIDITY OF LAKES IN SWEDEN.
Lund Inst. of Tech. (Sweden). Dept. of Chemical Engineering.
H. Sverdrup, and P. Warfvinge.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 71-78, 1990. 3 tab, 16 ref.

Descriptors: *Acid rain effects, *Acidity, *Forestry, *Lake acidification, *Sweden, *Water pollution sources, *Weathering, Alkalinity, Biomass, Forest watersheds, Hydrogen ion concentration, Limnology, Productivity.

The long-term acidity level of a lake is determined by the balance between acidity input to the catchment and the generation of alkalinity in the catchment. If the input of acidity through biomass net production and the production of alkalinity through weathering of minerals can be estimated, then the steady-state acidity level can be calculated for the lake under a certain acid deposition rate. Such a calculation has been carried out for 8 lakes ranging from acid to neutral. For lakes with the most sensitive soils in the catchment, the critical acid deposition load that will permit the lake to stay neutral may be less than zero acidity, indicating that forest growth is contributing to the acidification of a very sensitive system under the present forest management methods. (Author's abstract)
W91-04970

CONTROLS ON SURFACE WATER CHEMISTRY IN THE SOUTHERN BLUE RIDGE AND PIEDMONT PROVINCES.
R. E. Stauffer.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 79-96, 1990. 5 fig, 10 tab, 37 ref.

Descriptors: *Acid rain, *Geochemistry, *Surface water, *Water chemistry, *Water pollution sources, Acidification, Alkalinity, Blue Ridge, Calcium, Cations, Chemical interactions, Environmental chemistry, Gibbsite, Magnesium, Mountains, Nitrates, Piedmont Plateau, Potassium, Silica, Sodium, Sulfates, Weathering.

Using lake and stream data collected during the National Surface Water Survey (NSWS), and corrected for regional wet deposition and local cultural contamination, the role of weathering in supplying base cations C sub B, silica, and alkalinity was evaluated for the southern Blue Ridge (SBR) and southern Piedmont (SPM) Provinces of the United States. Silicate weathering can account for virtually all of the noncultural (Na + K) leaving the catchments, consistent with the weathering of feldspars to kaolinite, and in some dilute montane catchments, gibbsite. The net export of divalent C sub B (Ca + Mg) represents 62 to 66% (median values) of total C sub B export for the regional NSWS index sample populations; the alkalis account for the remainder. The median percentage (Ca + Mg) is significantly lower (53%) for SBR special sites, consistent with their unusual vulnerability to acid deposition. Exchange-leaching currently accounts for < 17% of the divalent CB mobilized in these SBR and SPM catchments, possibly because of the high regional retention rates for both nitrate and sulfate. (Author's abstract)
W91-04971

ASSESSMENT OF PERFORMANCE OF WET ATMOSPHERIC DEPOSITION SAMPLERS. PART 2. VALIDATION OF SITING CRITERIA.
Military Academy, West Point, NY. Science Research Lab.
For primary bibliographic entry see Field 7B.
W91-04972

OBSERVATIONAL STUDY ON PRECIPITATION CHEMISTRY DATA AS A FUNCTION OF SURFACE WIND DIRECTION.
Vrije Univ., Amsterdam (Netherlands). Dept. of Meteorology.
E. P. Weijers, and H. F. Vugts.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 115-132, 1990. 6 fig, 3 tab, 23 ref.

Descriptors: *Acid rain, *Chemical analysis, *Chemistry of precipitation, *Instrumentation, *Path of pollutants, *The Netherlands, *Water pollution sources, *Wind effects, Ammonia, Calcium, Chlorides, Dry deposition, Hydrogen ion concentration, Magnesium, Measuring instruments, Ruhr River Basin, Sodium, Sulfates, Wet deposition.

Precipitation chemistry data were collected at 8 sites in the western part of The Netherlands over a period of 15-1/2 years. Using specially designed wind direction dependent rain collectors, it was demonstrated that levels of ion constituents in rain water vary with wind direction, which can be assigned to different sources of contamination. The strongest variation was measured for Na. As expected, trajectories over sea contributed most. Continental sources slightly reduced the variation for Cl and Mg. For both NH4 and excess SO4, maxima were found in southeasterly rainfall. It is assumed that polluted air from the large industrial Ruhr Area crosses a region with strong NH3 emissions in the southeast and The Netherlands. The presence of ammonium sulfate was suggested. Minor variations were measured for NO3 (due to diffusely-spread emissions and possible sampling artifact) and for H and Ca (dry deposition effects). Over the period 1973-1987 excess SO4 levels decreased significantly (-3.3%/yr, $p < 0.01$) which is consistent with reduced S emission in Western Europe. Over the last decade an upward trend in NO3 levels has been observed (3.2%/yr, $p < 0.05$) which is possibly related to the increased usage of cars. (Author's abstract)
W91-04973

EFFECTS OF SOIL-CATION COMPOSITION ON REACTIONS OF FOUR HERBICIDES IN A CANDLER FINE SAND.
Florida Univ., Lake Alfred. Citrus Experiment Station.
A. K. Alva, and M. Singh.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 175-182, 1990. 2 fig, 2 tab, 15 ref.

Descriptors: *Cations, *Herbicides, *Leaching, *Path of pollutants, *Sand, *Soil density, *Water pollution sources, Aluminum chloride, Bromacil, Calcium chloride, Chlorides, Cupric chloride, Diuron, Ferric chloride, Florida, Norflurazon, Potassium chloride, Simazine, Sorption.

Sorption, persistence and transport of herbicides in soils depend on the relative saturation of soils with cations from various soil amendments. Research was conducted to study the effect of preequilibration of a Candler fine sand (Hyperthermic uncoated typic Quartzipsamments; 0-30 cm depth) with AlCl3, CaCl2, CuCl2, FeCl3, or KCl salt solutions on the sorption of bromacil, simazine, norflurazon, and diuron herbicides commonly used in Florida citrus groves. Preequilibration of the soil with either FeCl3, or AlCl3, significantly decreased the sorption and therefore increased the internal leaching potential, of all 4 herbicides as compared to their sorption in untreated soil. This decrease in sorption was much greater for bromacil and simazine (24 to 35%) than for norflurazon and diuron (7-8%). The desorption of bromacil and diuron in 1M NH4OAc was also significantly lower in soils preequilibrated with FeCl3 or AlCl3, than the untreated soil. However the reverse was true in the case of simazine and norflurazon. Preequilibration of the soil with CuCl2, KCl, and CaCl2 resulted in a significant decrease in sorption of norflurazon, diuron, and simazine but did not affect bromacil sorption. Accordingly, the species of adsorbed cations had varying effects on the sorption/desorption of each of the herbicides and varied their leaching potential. (Author's abstract)
W91-04975

INFLUENCES OF TEMPERATURE ON AQUEOUS ALUMINUM CHEMISTRY.
Norges Landbrukshoegskole, Aas. Isotope Lab.
For primary bibliographic entry see Field 2K.
W91-04977

INFLUENCE OF LABELLED FOOD TYPE ON THE ACCUMULATION AND RETENTION OF 60-CO BY A FRESHWATER FISH, CYPRINUS CARPIO L.
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Inst. de Protection et de Surete Nucleaire.
J. P. Baudin, A. F. Fritsch, and J. Georges.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 261-270, 1990. 4 fig, 3 tab, 32 ref.

Descriptors: *Bioaccumulation, *Cobalt radioisotopes, *Fish, *Fish food, *Path of pollutants, Biological magnification, Carp, Cobalt, Crustaceans, Midges, Snails.

A study was carried out on 3 groups of 10 fish, each fed on a different natural labeled food. The prey selected were a crustacean (Gammarus pulex), a midge larvae (Chironomus sp.), and the soft tissue from a snail (Lymnaea stagnalis), which are usually consumed by carp in the natural environment. The contaminated food consumption by the fish resulted in a 60-Co maximum transfer factor ranging from 0.0012 to 0.0051, depending on the food type. These values and the contamination kinetics indicate that biomagnification of radionu-

cleotides cannot occur, even over the long-term. Cobalt-60 depuration from fish was also influenced by the contaminated food type, previously ingested. Considering the three species of prey tested in the experiment, the highest transfer factor corresponded to the lowest elimination rate (Gammarus pulex) and vice-versa (Lymnaea stagnalis). (Author's abstract)
W91-04979

REMOVAL OF CU AND CD FROM WATER BY BACOPA MONNIERI L.
National Botanical Research Inst., Lucknow (India). Aquatic Botany Lab.
S. Sinha, and P. Chandra.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 271-276, 1990. 2 fig, 4 tab, 16 ref.

Descriptors: *Aquatic plants, *Cadmium, *Copper, *Fate of pollutants, *Path of pollutants, *Wastewater treatment, *Water pollution treatment, Bioaccumulation, Chlorophyll, Heavy metals, Macrophytes, Monitoring, Water pollution effects.

Copper and Cd accumulation was determined in Bacoda monnieri, a common aquatic plant. Plants showed an ability to accumulate both metals in single and mixed metal treatments. Copper accumulation was stimulated by the presence of Cd, whereas uptake of Cd was inhibited by Cu. A high tolerance to Cu and Cd was shown by the plants of B. monnieri at lower concentrations (0.05 and 0.1 mg/L). No phytotoxic symptoms were visible on plants at these concentrations. Chlorophyll content decreased initially but soon after 48 hr, it increased gradually. However, at higher metal concentrations, chlorophyll decreased considerably during the long exposure. These results suggest the possibility of using this plant for mitigating Cu and Cd pollution in the aquatic environment. Preliminary findings suggest the possible application of B. monnieri plants in wastewater treatment programs due to its ability to accumulate Cu and Cd. (Lantz-PTT)
W91-04980

PCB CONCENTRATIONS IN STREAM SUNFISH (LEPOMIS AURITUS AND L. MACROCHIRUS) IN RELATION TO PROXIMITY TO CHRONIC POINT SOURCES.
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. R. Southworth.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 287-296, 1990. 3 fig, 20 ref. DOE Contract No. DE-AC05-840R21400.

Descriptors: *Bioindicators, *Path of pollutants, *Polychlorinated biphenyls, *Sunfish, Bioaccumulation, Fish populations, Organic compounds, Population dynamics.

Sunfish (Lepomis auritus and L. macrochirus) were used to monitor polychlorinated biphenyl (PCB) contamination in a group of small streams flowing into a larger stream/reservoir system. Mean PCB concentrations in sunfish appeared to reflect exposure conditions at the site of capture. Fish from uncontaminated sites 1 to 2 km distant from PCB-contaminated sites did not exhibit PCB contamination, and PCB concentrations in fish downstream from a discrete source decreased at a rate greater than or equal to downstream dilution of the point source. Mean PCB concentrations in fish near the source exhibited relatively large (40%) fluctuations between semiannual sampling periods, suggesting that PCB concentrations in sunfish populations may respond rapidly to changes in exposure. Sunfish were not sensitive enough indicators of contamination to use in assessing whether or not problematic levels of contamination may occur in other species. Although the presence of PCB contamination in sunfish cannot be used to infer that PCBs are elevated in other species, the absence of PCB contamination in sunfish can be used to infer that older, fattier fish higher up in the food chain are uncontaminated. (Author's abstract)
W91-04982

CHLORIDE IN THE PORE WATER AND WATER COLUMN OF ONONDAGA LAKE, N.Y., U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
S. W. Effler, S. M. Doerr, C. M. Brooks, and H. C. Rowell.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 315-326, 1990. 5 fig, 2 tab, 29 ref.

Descriptors: *Chlorides, *Interstitial water, *New York, *Onondaga Lake, *Path of pollutants, *Vertical distribution, *Water pollution control, *Water pollution sources, Industrial wastewater, Limnology, Water chemistry.

The vertical distributions of Cl in the pore waters of the sediments and in the water column of Onondaga Lake, New York, were documented and used to estimate the diffusion flux of Cl across the sediment-water interface, and establish the reduction in lake concentrations that has occurred as a result of the closure of an industrial source of Cl. Despite the industrial enrichment of the water column with Cl over the last 100 year, gradients within the upper sediments toward the overlying water of 0.069 to 0.085 mg/cu cm/cm exist in the deep basins of the lake. These upward gradients are apparently a manifestation of the salt deposits that underlie the region. The estimated diffusion flux from the sediments to the water column, 3,200,000 kg/yr, represents a small percentage of the external load during the operation of the industry (0.4%) and after its closure (1.6%). The Cl concentration has decreased approximately 70% in response to an approximately equal percent reduction in external loading as a result of closure of the industry. This supports the position that the lake's concentrations largely reflect external loading and lake flushing associated with surface inputs. (Author's abstract)
W91-04983

REGIONAL SCALE MODEL FOR THE CALCULATION OF EPISODIC CONCENTRATIONS AND DEPOSITIONS OF ACIDIFYING COMPONENTS.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
H. J. Van Rheineck Leyssius, F. A. A. M. De Leeuw, and B. H. Kesseboom.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 327-304, 1990. 7 fig, 5 tab, 33 ref.

Descriptors: *Acid rain, *Model studies, *Path of pollutants, *Regional analysis, *Water pollution sources, Air pollution, Data interpretation, Dry deposition, Mathematical models, Nitrates, Sulfates, Wet deposition.

An eulerian long-range transport model was developed for the calculation of concentrations of SO2, SO4, NOx, and NO3 and wet and dry depositions of SOx (sum of S02 and S04) and NOx (sum of NO, NO2 and NO3) over Europe. The model is developed in such a way that only routinely available, analyzed or prognostic meteorological fields are required as input data. In this way it is possible to obtain a forecast of the air quality during smog episodes. For evaluation of smog episodes the model provides a way to estimate the contributions of different sources and the effect of emission scenarios. The model has been evaluated for four winter and three summer episodes. The modeled concentrations of SO2 and SO4 are in agreement with the available measurements. A lesser agreement is found for NO2 and Nox (sum of NO and NO2) concentrations. For these components the model tends to underpredict the measured values. (Author's abstract)
W91-04984

EFFECTS OF SEDIMENT-ASSOCIATED COPPER ON ECOLOGICAL STRUCTURE AND FUNCTION OF AQUATIC MICROCOSMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W91-04992

POLYCYCLIC AROMATIC HYDROCARBON METABOLISM IN THE POLYCHAETE NEREIS VIRENS.
Massachusetts Univ. at Boston. Environmental Science Program.
A. E. McElroy.
Aquatic Toxicology AQTODG, Vol. 18, No. 1, p 35-50, November 1990. 4 fig, 2 tab, 47 ref. NOAA Contract No. 83-ABD-00012.

Descriptors: *Biodegradation, *Fate of pollutants, *Metabolism, *Path of pollutants, *Polychaetes, *Polycyclic aromatic hydrocarbons, Aromatic compounds, Benthic fauna, Cytochromes, Hydrocarbons, Organic compounds.

Polychaetes exposed to C-14 benz(a)anthracene contaminated sediment, water or diets for periods of days to weeks rapidly accumulated and metabolized this polycyclic aromatic hydrocarbon (PAH) primarily to water soluble and unextractable compounds. Benz(a)pyrene hydroxylase activity measured in vitro in microsomes prepared from homogenates of the polychaetes in these experiments or in microsomes prepared from intestinal tissue homogenates from polychaetes injected with 3-methylcholanthrene, were indistinguishable from those measured in control organisms. These results indicate that forms of cytochrome p-450 responsible for aromatic hydrocarbon metabolism in this species may be constitutive. (Author's abstract)
W91-04993

POLYCHLORINATED BIPHENYLS IN EXTRACTS OF BRAIN FROM MANX SHEARWATERS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
J. T. Borlakoglu, J. P. G. Wilkins, C. H. Walker, and R. R. Dils.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 819-823, December 1990. 1 tab, 6 ref.

Descriptors: *Bioaccumulation, *Bioindicators, *Path of pollutants, *Polychlorinated biphenyls, *Tissue analysis, *Water birds, Arochlor, Brain, DDE, Food chains, Organic compounds, Physiological effects.

Polychlorinated biphenyls (PCBs) accumulate in the fatty tissues of fish-eating seabirds at the apex of marine food chains by the ingestion of PCB-contaminated lipid components of food. Measurements of the concentrations of PCBs that have accumulated can be used to monitor the pollution of the marine environment. The mean concentration of total PCBs in three tissue sample extracts was 75.5 microg/g of wet weight of brain. The mean concentration of p,p'-DDE, which is frequently present as a major chemical residue in the fatty tissues of many species, was 0.48 microg/g of wet weight of brain. Samples of brain tissue had low concentrations of cytochrome P-450 components of enzymes involved in the metabolism of drugs and other xenobiotics and did not metabolize C14-4-monochlorobiphenyl or C14-2,2',5,5'-tetrachlorobiphenyl at measurable rates. Of the 40 individual PCBs identified, 9 congeners accounted for 60% of the total concentration of PCBs in the tissue. These were mainly di-ortho-substituted congeners and were greatly enriched compared with their abundance in Arochlor 1260 and 1254. This suggests that their accumulation far exceeded their metabolism and excretion. (Lantz-PTT)
W91-05007

ORGANOCHLORINE CONTAMINANTS IN EGGS AND TISSUE OF WOOD DUCKS FROM MISSISSIPPI.
Mississippi Cooperative Fish and Wildlife Research Unit, Mississippi State.
W. M. Ford, and E. P. Hill.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 870-875, December 1990. 3 tab, 18 ref.

Descriptors: *Bioaccumulation, *Eggs, *Organic pesticides, *Path of pollutants, *Pesticides, *Tissue analysis, *Water birds, *Water pollution effects,

Chlorinated hydrocarbons, DDE, Mississippi, Reproduction, Toxaphenes, Waterfowl.

A recent study of green-back herons (Butorides striatus) in and around Yazoo National Wildlife Refuge (YNWR), Mississippi showed high concentrations of total DDT. Suppressed local hatching success and eggshell thinning from continued exposure to p,p'-DDE were also documented. Pesticide residues in eggs and body tissues of resident wood ducks, and pesticide induced eggshell thinning were the focus of the study. Analyses of wood duck eggs and whole body tissue for organochlorine pesticide residues were conducted at the Mississippi State Chemical Laboratory. The minimum detection level for all organochlorine compounds, including toxaphene, in tissue samples of wood duck eggs and wood ducks was 0.01 ppm. Results for all samples were reported on a wet weight basis. Wood duck eggs collected at YNWR and the Noxubee National Wildlife Refuge (NNWR), contained residues of p,p'-DDE. Eggs from YNWR also contained toxaphene, p,p'-DDD, and p,p'-DDT residues. The results indicate a trend in reduction of contaminant residue levels over a period between 1984 and 1988 in wood duck eggs. Reduced reproductive performance in wood ducks at YNWR was related to predation and intraspecific competition for nesting sites. (Lantz-PTT)
W91-05009

AMINO ACID SEQUENCE OF CADMIUM-BINDING PEPTIDE INDUCED IN A MARINE DIATOM, PHAEODACTYLUM TRICORNUTUM.
Hokkaido Univ., Sapporo (Japan). Research Inst. of North Pacific Fisheries.
S. Kawaguchi, and Y. Maita.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 893-899, December 1990. 4 fig, 4 tab, 12 ref.

Descriptors: *Biochemistry, *Cadmium, *Diatoms, *Fate of pollutants, *Path of pollutants, *Peptides, Amino acids, Bioaccumulation, Chemical interactions, Chromatography, Culturing techniques, Heavy metals, Marine environment, Proteins, Zinc.

The amino acid sequence of Cd-binding peptide was investigated. Phaeodactylum tricornutum was batch cultured in 0.5-5 L of Mutsu medium. Cadmium, copper and zinc were added to the experimental cultures. After 14 days, the cells were collected by centrifugation. The supernatant was chromatographed on a Sephadex G-75 column. The elution profile on Sephadex G-75 of the extract from cells cultured with 1 mg Cd/L was eluted as a single peak. Induction of binding peptides by individual additions of sublethal concentrations of Cu or Zn was not observed. However, additions of Cu and Zn to plankton growing in the presence of Cd caused the displacement of Cd in the binding peptide fraction with Cu. This suggests that the peptide has a higher affinity for Cu, than for Cd and Zn. Ion exchange chromatography of the Cd-rich fraction obtained by gel filtration showed a peak at 254 nm (cDBP-1) with a shoulder (CdBP-2). CdBP-1 and CdBP-2 consisted of only three species of amino acid, Glu, Cys, and Gly. Further analysis indicated that the peptide contained only 1 gly, located in the C-terminal position, and that Glu exists in the N-terminal. Based on all the characteristics of purified CdBP-1 in this study, it is concluded that CdBP-1 is identical with phytochelatin, (Gamma-Glu-Cys)4-Gly. (Lantz-PTT)
W91-05012

TRACE AND HEAVY METALS IN THE OYSTER CRASSOSTREA VIRGINICA, SAN ANDRES LAGOON, TAMAULIPAS, MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
F. Vazquez, G. Aguilera, D. Delgado, and A. Marquez.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 907-914, December 1990. 3 fig, 1 tab, 17 ref. Oceanographic Branch of the Mexican Navy and UNAM Grant 132.

Descriptors: *Bioaccumulation, *Heavy metals, *Oysters, *Path of pollutants, *San Andres Lagoon, *Seasonal variation, *Trace metals, Adsorption, Cadmium, Cobalt, Copper, Hydrogen ion concentration, Iron, Lead, Manganese, Mexico, Mollusks, Nickel, Salinity, Temperature, Zinc.

Seasonal variations of the concentrations of seven trace metals (Cd, Cu, Co, Fe, Mn, Ni, Pb, and Zn) in the American oyster Crassostrea virginica were determined in order to establish the levels of metal pollution in Mexican oysters. Changes in metal concentrations for each season and sampling station were not regular. Concentrations of Ni and Cd were homogeneous. Concentrations of Ni fell within the standard level for seafood (10 ppm). Concentrations of Cd were lower than the reported LC50 value (7.5 ppm). Iron ranged from 40.5 to 101.3 ppm and Mn from 13.5 to 49.5 ppm. Pb does not appear to be a matter for concern in seawater. Lead in C. Virginica ranged from 3.3 to 10.4 ppm. Zinc ranged from 269.4 to 6371.4 ppm. (Lantz-PTT)
W91-05014

TOXICITY OF CHAUTAUQUA LAKE BRIDGE RUNOFF TO YOUNG-OF-THE-YEAR SUNFISH (LEPOMIS MACROCHIRUS).
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W91-05016

PATTERN OF PARTICULATE NITROGEN TRANSPORT IN WORLD RIVERS.
Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelschemie.
V. Ittekkot, and S. Zhang.
Global Biogeochemical Cycles GBCYEP, Vol. 3, No. 4, p 383-391, December 1989. 3 fig, 5 tab, 39 ref.

Descriptors: *Amino acids, *Erosion, *Nitrogen, *Nutrient transport, *Path of pollutants, *Rivers, Carbon, Deforestation, Fertilizers, Flow rates, Particulate matter, Solute transport.

Samples from several major world rivers were analyzed for their particulate nitrogen (PN) contents, C/N ratios, and total particulate amino acid (TPAA) contents. The results show a global PN transport of 33 x 10(22) g N/yr, more than 80% of which occurs in rivers carrying high suspended matter concentrations such as the Ganges, Brahmaputra, Mekong, and Huanghe. Quantitatively, nitrogen transported in the particulate fraction excedes that reported for dissolved inorganic nitrogen. The bulk of the PN transport is associated with material having relatively low C/N ratios and low TPAA contents. TPAA accounted for about 20% of the total PN transport. Although natural processes leading to high rates of erosion in Asian rivers might have partly contributed to the observed PN transport pattern, the results suggest that human activities such as deforestation and increased use of nitrogen fertilizer in their drainage basins are an important factor. (Author's abstract)
W91-05018

KINETIC MODELS TO PREDICT BIOACCUMULATION OF POLLUTANTS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
C. H. Walker.
Functional Ecology FECOE5, Vol. 4, No. 3, p 295-301, 1990. 1 fig, 1 tab, 22 ref.

Descriptors: *Bioaccumulation, *Chlorinated hydrocarbons, *Mathematical models, *Model studies, *Path of pollutants, *Pesticides, Absorption, Aquatic environment, Diffusion, Ecology, Fish, Metabolism, Organic pollutants, Terrestrial environment.

Kinetic models to predict the bioaccumulation of pollutants in both aquatic systems and terrestrial organisms were examined. A model system for the bioaccumulation of lipophilic pollutants specified principal routes of pollutant uptake and loss for aquatic systems as diffusion. In the case of fish, in addition to the exchange of pollutants by diffusion, food becomes important as an uptake route and metabolism may be a significant route of loss. In terrestrial systems, the principal route of uptake for predators is food and the main route of loss is metabolism. The simple exchange diffusion model has been of some practical value for the prediction of bioconcentration factors in the field. A more complex model has been useful for predicting bioaccumulation by fish. A model for terrestrial predators is yet untested. Large species differences in rate of metabolism makes reliable predictions using data from laboratory animals impossible. It is concluded that predictive models for the bioaccumulation of pollutants may give forewarning of the potential risks of bioaccumulation of certain compounds in particular species. (MacKeen-PTT)
W91-05038

INTERACTIONS BETWEEN THE SURFACE OF RAINBOW TROUT, ONCORHYNCHUS MYKISS, AND WATERBORNE METAL TOXICANTS.
Dundee Univ. (Scotland). Dept. of Biological Sciences.
R. D. Handy, and F. B. Eddy.
Functional Ecology FECOE5, Vol. 4, No. 3, p 385-392, 1990. 3 fig, 1 tab, 35 ref.

Descriptors: *Bioaccumulation, *Fish, *Metals, *Path of pollutants, *Water pollution effects, Acid rain effects, Acidic water, Aluminum, Metal complexes, Nutrition, Toxicity, Trout, Zinc.

Interactions between waterborne metal toxicants and metal-binding ligands on the surface of fish are important in the processes of metal accumulation and toxicity. Metal toxicant-fish surface interactions were examined in relation to the initial stages of metal toxicant accumulation. Fish were exposed to short, laboratory-based episodes of Al or Zn in an artificial soft water, to simulate conditions which may occur in some freshwater environments. The gill tissue and body mucus were important sites of both Al and Zn absorption. Furthermore, Zn accumulation was exacerbated by starvation prior to episodic exposure, suggesting that both the dietary and waterborne routes should be considered in metal accumulation. Moreover, the higher rate of Zn accumulation by starved compared to fed fish can partly be explained by changes in body mucus during starvation. Mucus from fed and starved fish contained 2.0 and 0.5 mmol/L Na(+), respectively, suggesting that some metal-binding ligands in mucus from starved fish remain uncomplexed and available to bind toxic metal ions. The solute chemistry of soft water may also influence waterborne metal-fish surface interactions, effecting the absorption of non-toxic essential ions such as Na(+). Acidification of soft water decreased the absorption of Na(+) onto the body surface by 85% indicating that metal toxicity is a process of toxic ion accumulation and a reduction in the availability of essential waterborne Na(+). (Author's abstract)
W91-05040

USE OF CHEMICAL ANALOGUES SUCH AS EU/AM IN ECOTOXICOLOGICAL STUDIES.
Reading Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 5A.
W91-05047

ENVIRONMENTAL HEALTH.
For primary bibliographic entry see Field 6G.
W91-05051

PRODUCTION AND TRANSPORT OF CARBON DIOXIDE IN A CONTAMINATED VADOSE ZONE: A STABLE AND RADIOACTIVE CARBON ISOTOPE STUDY.
Arizona Univ., Tucson. Environmental Radioisotope Center.
K. H. Suchomel, D. K. Kreamer, and A. Long.
Environmental Science and Technology

ESTHAG, Vol. 24, No. 12, p 1824-1831, December 1990. 4 fig, 3 tab, 38 ref. EPA Grant CR-812583-01-0.

Descriptors: *Arizona, *Fate of pollutants, *Isotope studies, *Organic solvents, *Path of pollutants, *Pollutant identification, *Soil gases, Biodegradation, Carbon dioxide, Carbon isotopes, Organic pollutants, Soil contamination, Vadose zone, Wastewater disposal.

Analyses of soil gas compositions and stable and radioactive carbon isotopes in the vadose zone above an alluvial aquifer were conducted at an organic solvent disposal site in Phoenix, Arizona. The study investigated the source and movement of carbon dioxide above a plume of organic solvent contamination. Two soil gas monitor wells, each screened and grouted at four discrete depths above the water table, provided sampling access. One well penetrated the uncontaminated vadose zone, the other penetrated a contaminated area now covered with asphalt. Carbon dioxide concentrations in the uncontaminated area range from 1.45% at 8 ft and 3% at 19 ft below land surface. Isotopic evidence suggests root respiration and minor oxidation of organic matter as CO2 sources at this site. Carbon dioxide in soil gas samples from the contaminated area exceeded 15%, whereas O2 levels were as low as 1%. Carbon dioxide concentrations and carbon isotope values are consistent with in situ aerobic biodegradation of the organic pollutants. (Author's abstract)
W91-05072

ANION-EXCHANGE CHROMATOGRAPHY-PARTICLE BEAM MASS SPECTROMETRY FOR THE CHARACTERIZATION OF AROMATIC SULFONIC ACIDS AS THE MAJOR ORGANIC POLLUTANTS IN LEACHATES FROM STRINGFELLOW, CALIFORNIA.
California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.
For primary bibliographic entry see Field 5A.
W91-05073

ESTIMATION OF POLYCHLORINATED DIBENZOFURAN AND DIBENZO-P-DIOXIN CONTAMINATION OF A COASTAL REGION USING ISOMER PROFILES IN CRABS.
Norsk Inst. for Luftforskning, Lillestroem.
M. Oehme, A. Bartonova, and J. Knutzen.
Environmental Science and Technology ESTHAG, Vol. 24, No. 12, p 1836-1841, December 1990. 5 fig, 2 tab, 20 ref.

Descriptors: *Bioindicators, *Chlorinated hydrocarbons, *Coasts, *Crabs, *Dioxins, *Industrial wastewater, *Norway, *Path of pollutants, *Wastewater pollution, Bioaccumulation, Coastal areas, Isomers, Statistics, Wastewater disposal.

Compared to other marine biota such as fish, crabs lack the ability to metabolize most of the polychlorinated dibenzofuran (PCDF) and dibenzo-p-dioxin (PCDD) isomers. Therefore, they preserve nearly undisturbed the characteristic isomer profiles found the wastewater from a magnesium production plant in southern Norway. The isomer pattern of this process shows significant differences compared to other PCDF/PCDD sources such as combustion or the pulp industry. The isomer distribution and concentration levels were determined in pooled samples of stationary male crabs, which were collected within a distance of a few kilometers and more than 100 km from the source. Two main isomer distributions could be identified, one belonging to the Mg process and one more similar to that earlier reported from the Skagerrak region. When statistical methods such as discriminant or variance analyses were employed, the coastal area contaminated by the factory could be estimated to approximately 50 km downstream from the source. (Author's abstract)
W91-05074

KINETICS OF SELENATE AND SELENITE ADSORPTION/DESORPTION AT THE GOETHITE/WATER INTERFACE.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
P. Zhang, and D. L. Sparks.
Environmental Science and Technology ESTHAG, Vol. 24, No. 12, p 1848-1856, December 1990. 5 fig, 3 tab, 30 ref.

Descriptors: *Kinetics, *Minerals, *Path of pollutants, *Selenium, *Soil chemistry, *Water chemistry, Adsorption, Chemical reactions, Desorption, Goethite, Selenate, Selenite.

Kinetics and mechanisms of selenate and selenite adsorption/desorption at the goethite/water interface were studied using pressure-jump (p-jump) relaxation with conductivity detection at 298.15 K. The results of such kinetic studies should be useful in predicting the rate of retention and release of selenium species in soil, which in turn should permit prediction of the fate of Se in soils, as it affects surface and groundwater quality. A single relaxation was observed for selenate (SeO4(2-)) adsorption. This relaxation was ascribed to SeO4(2-) on a surface site through electrostatic attraction accompanied simultaneously by a protonation process. The intrinsic rate constant for adsorption was much larger than that for desorption. The intrinsic equilibrium constant obtained from the kinetic study (log K = 8.02) was of the same order of magnitude as that obtained from the equilibrium study (log K = 8.65). Unlike SeO4(2-), selinite adsorption on goethite produced two types of complexes XHSeO3(0) and XSeO3(-), via a ligand-exchange mechanism. Double relaxations were attributed to two reaction steps. The first step was the formation of an outer-sphere surface complex through electrostatic attraction. In the second step, the adsorbed selenite ion replaced a H2O from the protonated surface hydroxyl group and formed an inner-sphere surface complex. A modified triple layer model (TLM) was employed to describe the adsorption phenomena. The intrinsic equilibrium constants obtained from the equilibrium modeling and from the kinetic studies were similar, which further verified the hypothesized reaction mechanism. (Author's abstract)
W91-05075

CASE STUDY OF LEAD IN DRINKING WATER: PROTOCOL, METHODS, AND INVESTIGATIVE TECHNIQUES.
IBM Corp., Boulder, CO.
W. F. Davis.
American Industrial Hygiene Association Journal AIHAAP, Vol. 51, No. 12, p 620-624, 1990. 1 fig, 5 tab, 21 ref.

Descriptors: *Analytical methods, *Drinking water, *Lead, *Path of pollutants, *Plumbing, *Pollutant identification, *Water analysis, *Water pollution sources, Case studies, Colorado, On-site investigations, Remediation, Water pollution treatment.

A site study of lead in drinking water was performed at an IBM Corporation facility in Boulder, Colorado comprising 36 buildings. During the initial survey, 124 first draw samples were collected from water coolers and sinks and analyzed by atomic adsorption for total lead. Three of 71 water coolers sampled had lead levels >50 microg/L and 13 had levels in the 10-50 microg/L range. Two of the three water coolers having the highest lead levels were from the same manufacturer and were immediately replaced, as were other identical models. Of 56 faucets sampled, 9 had >50 microg/L Pb and 14 had 10-50 microg/L Pb. The solder scraping technique was used to identify whether lead was used in the solder. When lead solder was confirmed, all plumbing to the source was removed and replaced using lead-free solder. Follow-up sampling indicated that lead concentrations were reduced to acceptable levels. Water in the two newest buildings had average Pb levels of approximately 40 microg/L. These levels were reduced to <10 microg/L by 1-2 gal/min leaks introduced into the recirculating loop systems, at a cost of roughly $10,000/yr. The plumbing in both buildings was replaced by the contractor. A program at IBM Boulder to ensure that new sources of lead are not introduced into drinking water includes enforcement of specifications for lead-free solder, tool box audits, and solder analysis. It is concluded that the most effective way to eliminate lead from water in plumbing systems is to use nonlead materials. (MacKeen-PTT)
W91-05089

AEROBIC BIODEGRADATION OF VINYL CHLORIDE IN GROUNDWATER SAMPLES.
Dow Chemical Co., Midland, MI. Health and Environmental Sciences.
J. W. Davis, and C. L. Carpenter.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 12, p 3878-3880, December 1990. 2 fig, 1 tab, 15 ref.

Descriptors: *Aerobic conditions, *Biodegradation, *Fate of pollutants, *Groundwater pollution, *Microbial degradation, *Vinyl chloride, Aquifer characteristics, Microorganisms, Mineralization, Oklahoma, Radioactive tracers, South Canadian River.

The aerobic degradation of vinyl chloride by naturally occurring microorganisms in groundwater was examined. Aquifer material was obtained from a site located on the northern bank of the South Canadian River from an area bordering the municipal landfill in Norman, Oklahoma. Biodegradation of C-14 labelled vinyl chloride was examined in microcosms prepared with subsurface soil and groundwater. Under aerobic conditions, vinyl chloride was readily degraded, with greater than 99% of the labeled material being degraded after 108 days and approximately 65% being mineralized to C-14 labelled carbon dioxide. The microorganisms present in the aquifer were capable of mineralizing vinyl chloride at concentrations of 100 ppb and below. The results indicate that vinyl chloride can be rapidly degraded under aerobic conditions. The absence of an observable lag or adaptation period suggests a widespread ability of soil and groundwater microorganisms to degrade vinyl chloride. (MacKeen-PTT)
W91-05098

ACTIONS AND INTERACTIONS OF TEMPERATURE AND PHOTOPERIOD ON MERCURY ACCUMULATION BY ELODEA DENSA FROM SEDIMENT SOURCE.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
R. Maury-Brachet, F. Ribeyre, and A. Boudou.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 141-155, October 1990. 4 fig, 34 ref.

Descriptors: *Bioaccumulation, *Bottom sediments, *Mercury, *Path of pollutants, *Synergistic effects, Ecosystems, Heavy metals, Photoperiod, Rooted aquatic plants, Sediments, Temperature effects.

Actions and interactions of two abiotic parameters--temperature (18, 21 and 24 C) and photoperiod (8, 12, and 16 h/day)--on mercury bioaccumulation by a rooted macrophyte species, Elodea densa, from a sediment source were studied. Comparative analysis of shoot growth was made to examine a possible inhibiting action by the metal. The total amount of mercury accumulated in the whole plant after a 28-day exposure was 40 times greater when the mercury was added as methyl mercury than when added in the inorganic form. Temperature and photoperiod had a strong influence on methyl mercury accumulation by the plants, separately and in interaction. The interactions generally represent an amplification of effects produced by each abiotic factor, although this synergy varied according to the accumulation criteria being considered or to the part of the plant analyzed (whole plant, leaves, or stems). (Author's abstract)
W91-05103

LEVELS OF TOTAL CYANIDE AND NACL IN SURFACE WATERS ADJACENT TO ROAD SALT STORAGE FACILITIES.
Maine Univ. at Orono. Dept. of Plant and Soil Sciences.
T. Ohno.

Environmental Pollution ENPOEK, Vol. 67, No. 2, p 123-132, 1990. 3 fig, 3 tab, 15 ref.

Descriptors: *Cyanide, *Deicers, *Path of pollutants, *Sodium chloride, *Surface water, *Water pollution sources, Leaching, Seasonal variation, Soil absorption capacity, Water pollution, Wetlands.

Concentrations of Na, Cl, and total cyanide (simple + complex forms of cyanide) in surface waters adjacent to uncovered, outdoor sand-salt storage facilities were monitored for the calendar year 1988. Runoff of deicing salt from these unprotected sand-salt piles resulted in Cl concentrations up to 13,500 mg/L in surrounding surface waters, indicating substantial leaching of road salt from sand/salt storage lots. The use of sodium hexacyanoferrate(II) as an anti-caking agent in road salt resulted in up to 200 microg/L total cyanide (CN) in surface waters adjacent to sand-salt piles. Concentrations of Na and Cl were highest during the summer months whereas the concentrations of total CN were highest during the autumn months. The observed concentrations of CN were less than the calculated maximum concentrations based on total CN content in pure road salt, indicating that sodium hexacyanoferrate(II) was being adsorbed during overland flow onto soils and/or sediments of the wetlands. A laboratory adsorption study using five soils and a road salt solution showed that the soils adsorbed from 25 to 83% of the sodium hexacyanoferrate(II) present in the soil-road salt suspensions. The percentage of sodium hexacyanoferrate(II) adsorbed on soils increased with decreasing soil pH. (Author's abstract)
W91-05111

CONCENTRATIONS OF SYNTHETIC ORGANIC CHEMICALS IN LEACHATE FROM A MUNICIPAL LANDFILL.
McNeese State Univ., Lake Charles, LA.
H. E. Murray, and J. N. Beck.
Environmental Pollution ENPOEK, Vol. 67, No. 3, p 195-203, 1990. 3 fig, 1 tab, 16 ref.

Descriptors: *Landfills, *Leachates, *Municipal wastes, *Organic compounds, *Path of pollutants, *Pesticides, *Water pollution sources, Chlorinated hydrocarbon insecticides, Halogenated hydrocarbons, Hydrocarbons, Lake Charles, Louisiana, Observation wells, Polycyclic aromatic hydrocarbons, Water quality standards.

A study on the concentrations of synthetic organic chemicals in leachate from the municipal landfill of Lake Charles, Louisiana, was conducted from June 1987 through March 1989. Mean concentrations of total halogenated aromatic compounds were 0.772, 0.380, and 0.233 microg/L for leachate collected from three monitoring wells (MW1, MW2, and MW3). Mean levels of total polynuclear aromatic hydrocarbons were 0.448, 0.301, and 1.220 microg/L in leachate from MW1, MW2, and MW3, respectively. Mean levels of contaminants in leachate from MW1, located outside the perimeter of the landfill, were as follows: Aldrin, 0.333 microg/L; Dieldrin, 0.104 microg/L; total BHCs, 0.465 microg/L; total Heptachlor, 0.148 microg/L; total DDTs, 0.647 microg/L; and total Endrin, 0.325 microg/L. A number of the organic compounds identified in the leachate are included in the EPA drinking water standards. It is recommended that a more intensive evaluation of both municipal and industrial landfill leachates be conducted. (MacKeen-PTT)
W91-05112

PESTICIDE RESIDUES IN FRESHWATER AND MARINE ZOOPLANKTON: A REVIEW.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
K. E. Day.
Environmental Pollution ENPOEK, Vol. 67, No. 3, p 205-222, 1990. 1 fig, 3 tab, 75 ref.

Descriptors: *Literature review, *Path of pollutants, *Pesticide residues, *Pesticides, *Water pollution effects, *Zooplankton, Aquatic animals, Bioaccumulation, Herbicides, Organophosphorus pesticides, Pesticide toxicity, Pyrethrins.

A review of the scientific literature on pesticide residues in freshwater and marine zooplankton is presented. At nil to very low concentrations of pesticides in the environment, there may be no detectable residues in the organism and no observable biological effects. Conversely, the organism may experience a toxic effect but the residues within the organism may be below the level of analytical detection. Pesticides which fall into this category include the organophosphate insecticides, the synthetic pyrethroids and many herbicides. As concentrations of pesticides in the environment increase or under conditions of continuous input of persistent, lipophilic chemicals, organisms may bioaccumulate residues to detectable levels. Factors which influence these levels include environmental variables, the physiological condition of the organism, the physicochemical characteristics of the pesticide, and the presence of dissolved and particulate organic matter. Detectable residues of pesticides in zooplankton may not necessarily cause a toxic effect, due to the capacity of animals to tolerate or store large concentrations of the chemical in their bodies. The presence of lipophilic and persistent organochlorine insecticides in routine biomonitoring may not necessarily have associated toxicity, although the long-term biological effects of these residues in zooplankton are unknown. The main environmental hazard resulting from residues of pesticides in zooplankton may prove to be transfer of these chemicals to higher trophic levels where their detrimental effects, at least in the well-known case of DDT, have been demonstrated. (MacKeen-PTT)
W91-05113

USE OF SELECTED AUTOCHTHONOUS SOIL BACTERIA TO ENHANCE DEGRADATION OF HYDROCARBONS IN SOIL.
Universidad Nacional de La Plata (Argentina). Facultad de Ciencias Exactas.
For primary bibliographic entry see Field 5G.
W91-05114

SOIL NITRATE PROFILES UNDER IRRIGATION ON COASTAL PLAIN SOILS.
Delaware Univ., Newark. Dept. of Agricultural Engineering.
W. F. Ritter, A. E. M. Chirnside, and R. W. Scarborough.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 738-751, 1990. 9 fig, 8 tab, 20 ref.

Descriptors: *Delaware, *Fertilizers, *Groundwater pollution, *Irrigation effects, *Nitrates, *Nonpoint pollution sources, *Water pollution sources, Agricultural runoff, Corn, Leaching, Nebraska, Soil contamination, Soybeans.

A number of reports have indicated that irrigation has increased the nitrate concentrations in groundwater. In the Platte River Valley of Nebraska, a study attributed the increase in nitrate levels to leaching of nitrogen in fertilizer applied to corn on coarse-textured and medium-textured soils. Similar reports have appeared covering various parts of the United States. Soil samples were taken in the fall of 1983 from the surface to a depth of 152 cm on 16 irrigated sites and one forested site in Delaware. All but one of the irrigated sites had corn grown on it in four out of the five preceding years. Soil types of the irrigated sites were Matapeake silt loam, Sassafras sandy loam, Woodstown sandy loam, Rumford loamy sand, and Evesboro loamy sand. Soil samples also were taken in the fall of 1983 and spring of 1984 from irrigated corn plots where poultry manure and ammonium nitrate fertilizer were applied at a rate of 202 kg/ha of available N. Nitrate concentrations were lower on the forested site than any of the cropland sites. Nitrate leaching was occurring to some extent on all of the irrigated corn sites. The greatest nitrate concentrations in the soil profile occurred where excessive nitrogen was applied using manure in addition to commercial fertilizer. The site where soybeans had grown in the previous four growing seasons had lower nitrate concentrations than any of the cropland sites. Nitrate concentrations were lower at greater depths on the corn plots in the spring of 1984 than in the fall of 1983. The most dominant factor affecting the fall nitrate profile levels is the total amount of N applied. (Rochester-PTT)
W91-05129

FLUORESCENCE QUENCHING AND POLARIZATION STUDIES OF NAPHTHALENE AND 1-NAPHTHOL INTERACTION WITH HUMIC ACID.
Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.
M. J. Morra, M. O. Corapcioglu, R. M. A. von Wandruszka, D. B. Marshall, and K. Topper.
Soil Science Society of America Journal SSSJD4, Vol. 54, No. 5, p 1283-1289, September/October 1990. 4 fig, 2 tab, 48 ref.

Descriptors: *Analytical techniques, *Fate of pollutants, *Fluorometry, *Path of pollutants, Soil contamination, Water pollution, *Humic acids, *Naphthalene, *Polarization, Fluorescence quenching, Model studies, Adsorption spectra, Soil chemistry.

The environmental behavior and fate of synthetic organic compounds are altered on association with humic materials, but the nature of this interaction has been a source of controversy. Fluorescence quenching and polarization techniques were used to study the interaction between water-soluble humic acid and naphthalene and 1-naphthol. Stern-Volmer plots constructed using intensity values for these fluorophores dissolved in humic acid solutions (0 to 25 mg/L) were linear. The ultraviolet/visible absorption spectra of each fluorophore in the presence and absence of the humic acid quencher were identical. This result, in addition to the observed increase in quenching with temperature, indicates a dynamic (collisional) mode of quenching. Fluorescent lifetimes of the probes decreased in the presence of humic acid, providing further evidence of dynamic quenching. However, the slopes of Stern-Volmer plots constructed with lifetime values were considerably smaller than plots obtained with intensity values. Calculated bimolecular quenching constants of 52,000,000,000 /M/sec for naphthalene and 480,000,000,000 /M/sec for 1-naphthol are above the maximum considered possible for a diffusion-controlled interaction. Fluorescence-polarization measurements indicate no rigid association between unquenched 1-naphthol and humic acid. The interaction of naphthalene and 1-naphthol with humic acid in aqueous solution occurs through a loose association in which humic acid surrounds the fluorophore in a cage-like manner. This pseudomicelle confines the probe without rigidly binding, thus promoting frequent quenching collisions and a combination of dynamic and static quenching. (Author's abstract)
W91-05180

FLUORESCENCE SPECTROSCOPY OF AQUEOUS LEAF LITTER EXTRACTS AND THEIR COMPLEXES WITH ALUMINUM.
Bern Univ. (Switzerland). Geological Inst.
For primary bibliographic entry see Field 2K.
W91-05181

DISTRIBUTION OF LONG-LIVED RADIONUCLIDES IN AN ABANDONED REACTOR COOLING RESERVOIR.
Savannah River Ecology Lab., Aiken, SC.
F. W. Whicker, J. E. Pinder, J. W. Bowling, J. J. Alberts, and I. L. Brisbin.
Ecological Monographs ECMOAQ, Vol. 60, No. 4, p 471-496, December 1990. 13 fig, 5 tab, 94 ref. Department of Energy Contract DE-AC09-76SR00-819.

Descriptors: *Cooling water, *Fate of pollutants, *Sediment contamination, *South Carolina, *Nuclear reactors, *Radioisotopes, *Radioactive wastes, Cesium radioisotopes, Strontium radioisotopes, Plutonium radioisotopes, Americium radioisotopes, *Radioisotope concentration, Radioactive decay, Flow discharge, Seston, Suspended sediments, Macrophytes, Recreation.

The distribution of cesium-137, strontium-90, plutonium-238, plutonium-239, 240, americium-241, and curium-244 was studied in the biotic and abiotic components of an abandoned reactor cooling impoundment, Pond B. The impoundment is located at the United States Department of Energy's Savannah River Plant in South Carolina. It received radioactive contaminants via cooling water discharges from R Reactor from September 1961 to June 1964. The radionuclide inventories were estimated in water, seston, sediments, and biotic components after 20 yr of equilibration. Chemical, physical, and biological relationships to the radionuclide distribution patterns were investigated. Biotic components contained some of the highest radionuclide concentration ratios observed to date. However, most of the radioactivity resides in sediments. The principal mechanisms of loss from the system are radioactive decay and periodic outflow of water and suspended materials; biotic export and seepage appear to be inconsequential. Strontium-90 was much more mobile in the system than the other radionuclides. Aquatic macrophytes dominated the biotic component radionuclide inventories and their dynamics exert a strong influence on the spatial distribution and turnover of radioactivity in the ecosystem. Pond B supports a diverse and productive flora and fauna. Cleanup of the system is not indicated. Use of Pond B for recreation is feasible with adequate attention to monitoring and radiological health guidelines. (Author's abstract)
W91-05200

MICROBIOLOGY AND WATER CHEMISTRY OF TWO NATURAL SPRINGS IMPACTED BY GRAZING IN SOUTH CENTRAL NEVADA.
Nevada Univ., Las Vegas. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W91-05204

PHYSICAL AND CHEMICAL ANALYSIS OF EGYPT'S WADI EL-RAIYAN MAN MADE LAKES.
Texas Southern Univ., Houston. Dept. of Chemistry.
B. L. Wilson, and M. A. Saleh.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 7, p 775-784, October 1990. 3 tab, 21 ref. Grant No. FRCU 842020.

Descriptors: *Irrigation runoff, *Nonpoint pollution sources, *Water pollution sources, Evaporation, Phosphates, Sulfides, Sulfur compounds, *Egypt, *Artificial lakes, *Salinity, *Drainage water, Dissolved oxygen, Hydrogen ion concentration, Lake fisheries, Nitrites, Sulfides, Phosphates.

Detailed physical and chemical analyses of selected sites in two Wadi El-Raiyan lakes in the El-Faiyum Province of Egypt were conducted over a 2-year period. These man-made lakes with a surface area of about 200 sq. km were created in early 1973 as a reservoir for agricultural irrigation drainage water in the western desert of Egypt. Evaporation coupled with a very low precipitation led to a rapid increase in salinity and trace metal content. The salinity was 0.5 ppt near the source tunnel and increased gradually to 1.0 at the first lake and to an average of 2.0 in the second lake. Salinity at the water spring was constant but increased dramatically to 7 ppt at the seepage area. Water pH was neutral to slightly basic (7.8-8.8) and constant throughout the lakes. Dissolved oxygen in the lakes varied from 6.2-11 mg/l and ammonium nitrogen from 0.02-0.05 ppm. Nitrite, sulfide, phosphate and thiocyanate concentrations were very low while halides and sulfates were relatively high (515-1285 ppm). These values are suitable for fish production and recreational purposes. (Medina-PTT)
W91-05205

LABORATORY AND IN-SITU SEDIMENT OXYGEN DEMAND DETERMINATIONS FOR A PASSAIC RIVER (NJ) CASE STUDY.
New Jersey Agricultural Experiment Station, New Brunswick.
J. V. Giga, and C. G. Uchrin.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 7, p 833-845, October 1990. 5 fig, 2 tab, 11 ref. New Jersey Department of Environmental Protection and New Jersey Agricultural Experiment Station Grant, Publication No. D-07524-1-90.

Descriptors: *Passaic River, *Path of pollutants, *Fate of pollutants, *Sampling, Comparison studies, Laboratory methods, In situ tests, *Sediments, *Biochemical oxygen demand, *River sediments, Mathematical models, Temperature, Flow rates.

Results from laboratory method for determining stream sediment oxygen demand (SOD) were compared to in situ measurements performed concurrently at sampling stations on the Passaic River in New Jersey. In situ methods are generally preferable since the stream bottom can remain relatively undisturbed at ambient temperatures and overlying water can be used. There was some variation in the SOD values between samples taken at different times from the same sampling station. These variations appeared to be randomly distributed and were most likely a function of river flow rate fluctuations and also sample collection variation. A virtual 1:1 correlation was noted for in situ measurements at temperatures greater than 18 C. (Medina-PTT)
W91-05208

ABILITY OF SOIL UNDER FOREST TO PURIFY FERTILIZER-POLLUTED RUNOFF.
Desnal Anti-Erosion Experimental Station, Ukrainian Institute of Agricultural and Forestry Melioration.
Y. D. Matukhno.
Soviet Soil Science SSSCAE, Vol. 21, No. 5, p 18-22, 1989. 1 fig, 3 tab, 18 ref.

Descriptors: *Fate of pollutants, *Forest soils, *Nutrient removal, *Path of pollutants, *Runoff, *Fertilizers, *Water pollution treatment, Ammonium, Soil horizons, Soil profiles, Percolation, Nutrient concentration, Loam.

The ability of soils under forests to sorb nutrients from percolating runoff was studied in field and laboratory experiments. Light loam gray forest soil and sandy-loam sodpodzolic soil under forests do not provide sufficiently effective removal of ammonium nitrogen from percolating runoff in a 1 m thick profile. The presence of macrogaps in soils promotes the penetration of largely unaltered polluted waters deep into the soil. Further purification of the runoff takes place in the lower soil horizons and in the subsoil; the concentrations of nutrients (other than nitrates) in the subsoil waters, where the aquifers lie at depths of 10 m or more, are safe. The parent material is capable of further purifying the percolating water even at a nutrient load ten times the ordinary load. Purification by loam is several times as efficient as purification by sand. (Brunone-PTT)
W91-05216

NITROGEN LOSSES FROM THE SOIL WITH INFILTRATING WATER IN A FERTILIZED PINE STAND.
Belorussion Scientific-Research Institute of Forestry, USSR.
V. S. Pobedov, V. V. Kopytkov, Y. A. Lebedev, A. I. Sviridenok, and L. S. Koretskaya.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 14-19, 1990. 5 tab, 11 ref.

Descriptors: *Nutrient transport, *Coniferous forests, *Fertilization, *Forest hydrology, *Forest management, Pine trees, *Nitrogen, *Soil chemistry, *Infiltration, Ammonium, Nitrites, Calcium, Magnesium, Nitrates.

Nitrogen is lost with infiltrating water when normal and slow-acting fertilizers are applied in pine plantations. Nitrogen losses from normal ammonium nitrate, applied at a rate of 150 kg/ha in a mature mossy pine forest, over 3.5 years amounted to 24.86 kg/ha (17%) of the rate applied, while nitrogen losses from slow-acting fertilizers at the same application rates were only 7%. Nitrogen is leached mainly as nitrate; significantly less is leached as ammonia, and insignificant amounts are leached as nitrites. Application of nitrogen fertilizers to a 70-year-old mossy pine forest led to an increase in the concentration of calcium, magnesium, and potassium in the infiltrating water. (Brunone-PTT)
W91-05223

BIOCHEMISTRY OF HEAVY METALS IN AN URBAN ENVIRONMENT.
Moscow State Univ. (USSR). Dept. of Soil Science.
A. I. Obukhov, and O. M. Lepneva.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 44-53, 1990. 3 fig, 5 tab, 18 ref.

Descriptors: *Soil chemistry, *Path of pollutants, *Urban areas, *Urban runoff, *Heavy metals, *Moscow, Trace metals, *Water pollution sources, Plant physiology, Seasonal variation, Absorption, Snowmelt.

The state of heavy metals (HM) in natural components of an urban environment was studied in Moscow. The distribution patterns of HMs in soils and plants from grass strips along highways and in large city parks were examined. The various forms of HM compounds in soils and their current supply to the soil surface average 60 mg/kg for lead, 230 mg/kg for zinc, 80 mg/kg for copper, and 0.7 mg/kg for cadmium. These values exceed typical levels of sod-podzolic soils by four to six times. The level of HM in the soils of grass strips along radial highways increases toward the center of the city, and varies as a function of the distance from the pavement. During precipitation, some of the pollutants are washed from plant leaves into the soil and other are absorbed into plants. Thus, the content of HMs in plants varies greatly with the seasons. Approximate flows of HMs can be determined from analysis of the snowcover. The meltwater from the snow of large parks far from the city center contains 2 to 6 microg of lead, 23 to 46 microg of zinc, 4 to 12 microg of copper, and 0.2 to 0.3 microg of cadmium per liter. The neutral or slightly alkaline reaction typical of meltwater also lowers the solubility of HMs. (Brunone-PTT)
W91-05224

REMOVAL OF NATURAL RADIONUCLIDES FROM SOIL IN LYSIMETRIC WATER.
L. T. Fevraleva, T. A. Fedorova, and Y. T. Bobrikova.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 58-60, 1990. 3 tab, 4 ref.

Descriptors: *Lysimeters, *Path of pollutants, *Radioisotopes, *Soil chemistry, *Soil water, *Solute transport, Uranium radioisotopes, Radium radioisotopes, Lead radioisotopes, Polonium radioisotopes, Thorium radioisotopes, Irrigation.

The behavior of uranium-238, radium-226, lead-210, polonium-210, and thorium-232 in soil and irrigation water was studied in a lysimeter experiment. Uranium-238 was sorbed to a lesser degree by the soil and was removed to a greater extent by infiltration water than radium-226 and its daughter nuclides (lead-210 and polonium-210). When a uranium solution was added to the soil, the amount removed by water was 0.22%, 10 times as great as the control. Thorium-232 was leached from the soil to the smallest extent, 0.0002% of the amount present in the soil. The mineral concentration of the infiltration water had no significant effect on the level of removal of radionuclides from the soil. (Brunone-PTT)
W91-05225

DEGRADATION OF TERBACIL IN SOIL.
Institute of Phytopathology, Moscow Region, USSR.
Y. Y. Spiridonov, V. G. Shestakov, Y. M. Matveyev, and L. M. Dykova.
Soviet Soil Science SSSCAE, Vol. 22, No. 1, p 61-65, 1990. 3 fig, 1 tab, 18 ref.

Descriptors: *Fate of pollutants, *Microbial degradation, *Terbacil, *Herbicides, *Path of pollutants, *Soil contamination, *Soil water, Temperature, Soil types, Chernozems, Kinetics, Microorganisms, Activation energy.

The degradation of Terbacil, a soil herbicide used to destroy annual and perennial weeds, in sod-podzolic, gray forest, chestnut brown, and Chernozem soils in the laboratory is described with satisfactory accuracy by first-order kinetics. The soil factors with the greatest influence on the degradation of Terbacil are moisture and temperature. Results indicate that Terbacil was broken down most slowly when the moisture content was 40% of field capacity and most rapidly at 100% of field capacity; a further rise in moisture content did not increase the rate of degradation. The degradation of Terbacil in soils is well described by first-order kinetics. The low calculated activation energy, which ranges from 21.1 to 42.6 kJ/mole in the different soil types, indicates pronounced biocatalysis of the degradation of Terbacil in the soil, most probably by the vigorous action of soil microorganisms. (Brunone-PTT)
W91-05226

EFFECT OF IRRIGATION WATERS POLLUTED WITH INDUSTRIAL WASTES ON HEAVY-METAL CONCENTRATION IN SOIL AND IN CERTAIN CROPS.
Erevan State Univ. (USSR).
K. V. Grigoryan.
Soviet Soil Science SSSCAE, Vol. 22, No. 2, p 121-128, 1990. 3 tab, 19 ref.

Descriptors: *Water pollution effects, *Irrigation effects, Crop production, Copper, Lead, Manganese, Nickel, *Path of pollutants, *Industrial wastes, *Heavy metals, *Soil contamination, *Agriculture, Plant physiology, Bioaccumulation, Trace minerals, Forest soils.

Irrigation with polluted waters leads to an increase in heavy-metal concentrations in soil and cultivated crops. On polluted soils, plants have a relatively high content of heavy metals. A strong correlation is observed between the content of copper, lead, nickel and manganese in cinnamon-brown forest steppe soil and in leaves of cultivated crops. A scale of heavy metal contamination of cultivated crops was established. Irrigation of cinnamon-brown forest steppe soils with waters of the Debed River polluted with industrial wastes leads to bioaccumulation of heavy metals. The content of copper, lead, nickel and manganese in polluted soils is well above their maximum permissible concentration. The content of heavy metals in cultivated crops increases with their increasing concentration in the soil, and on polluted soils, plants have a relatively high content of heavy metals. (Brunone-PTT)
W91-05235

PETROLEUM CONTAMINATED SOILS. VOLUME 2: REMEDIATION TECHNIQUES, ENVIRONMENTAL FATE, RISK ASSESSMENT, ANALYTICAL METHODOLOGIES.
For primary bibliographic entry see Field 5G.
W91-05236

CURRENT ISSUES IN MANAGEMENT OF MOTOR FUEL CONTAMINATED SOILS.
American Petroleum Inst., Washington, DC.
For primary bibliographic entry see Field 5G.
W91-05240

UNDERGROUND STORAGE TANK RELEASES IN ARIZONA: CAUSES, EXTENT, AND REMEDIATION.
Arizona Dept. of Environmental Quality, Phoenix. Hydrology Section.
For primary bibliographic entry see Field 5G.
W91-05243

ANALYSIS OF PETROLEUM CONTAMINATED SOIL AND WATER: AN OVERVIEW.
Massachusetts Univ., Amherst. Chenoweth Lab.
For primary bibliographic entry see Field 5A.
W91-05245

PROBLEMS ASSOCIATED WITH ANALYSIS OF PETROLEUM-DERIVED MATERIALS IN THE ENVIRONMENT.
Iowa Univ., Iowa City. State Hygienic Lab.
For primary bibliographic entry see Field 5A.
W91-05248

THREE COMMON MISCONCEPTIONS CONCERNING THE FATE AND CLEANUP OF PETROLEUM PRODUCTS IN SOIL AND GROUNDWATER.
Dragun Corp., Berkley, MI.
J. Dragun, and J. Barkach.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 149-155, 3 tab, 16 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Oil pollution, *Soil contamination, *Groundwater pollution, Soil properties, Geohydrology, Permeability, Organic compounds, Benzenes, Xylenes, Toluene, Monitoring, Water table.

There are three fallacies commonly asserted when discussing the fate of petroleum in the environment. First, soil macropores can cause bulk hydrocarbons to migrate quickly downward toward the water table without leaving significant amounts of residual saturation on unsaturated zone soil. In addition, some organic solvents can react with soil and cause soil shrinkage resulting in substantial increase in soil permeability. Second, soils as well as petroleum and its products are comprised of hundreds of individual organic chemicals including benzene, xylene, toluene, and ethylbenzene. The presence of low levels of these organic chemicals soil or groundwater should not be immediately and unequivocally interpreted as irrefutable evidence of a discharge of petroleum or its products. The natural occurrence of these chemicals should be evaluated before on reaches the definitive conclusion that a spill or leak has occurred. Third, soil gas surveys can provide useful information regarding the presence of petroleum products in soil and groundwater in some soil systems. In general, any soil condition that inhibits or restricts the migration of a chemical in soil air can lead to the generation of unreliable data. The following conditions favor successful soil gas surveys: sandy and gravely soil textures, a shallow water table, static sampling methods for deeper water tables and for finer soil types, laboratory instrumentation, and the presence of low molecular weight organic chemicals. (See also W91-05236) (Lantz-PTT)
W91-05249

EFFECT OF WATER-SOLUBLE ORGANIC MATERIAL ON THE TRANSPORT OF PHENANTHRENE IN SOIL.
Weston (Roy F.), Inc., West Chester, PA.
B. R. Magee, A. T. Lemley, and L. W. Lion.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 157-176, 9 fig, 4 tab, 45 ref.

Descriptors: *Soil properties, *Path of pollutants, *Organic matter, *Phenanthrene, Organic compounds, Tannic acid, Humic matter, Clay, Sand, Model studies, *Soil contamination.

Not all forms of dissolved organic carbon can be proposed as equally effective carriers of phenanthrene in soil. Even though they may solubilize hydrophobic compounds, many potential carriers such as tannic acid, humic acid, or even water soluble soil organic matter (WSSOM) may sorb too strongly to soil to facilitate transport. In some cases, WSSOM can be an effective carrier. WSSOM derived from a clayey silty loam contained a variety of hydrophilic and hydrophobic functional groups and was relatively unaltered by its passage through a sand column. WSSOM enhanced the transport of phenanthrene through sand by an average factor of 1.8, even though WSSOM itself was retarded (R=3.2). However, phenanthrene transport was not enhanced in the Rhinebeck soil from which the WSSOM was derived. A model which incorporates three distribution coefficients was effective in estimating retardation in a sand column in the presence of WSSOM. (See also W91-05236) (Lantz-PTT)
W91-05250

USING SOIL VAPOR CONTAMINANT ASSESSMENT AT HYDROCARBON CONTAMINATED SITES.
EA Engineering, Science, and Technology, Inc., Symrna, GA.
H. J. Reisinger, J. M. Kerr, R. E. Hinchee, D. R. Burris, and R. S. Dykes.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 303-317, 9 fig, 2 tab, 4 ref.

Descriptors: *Soil vapor surveys, *Site remediation, *Volatile organic compounds, *Soil contamination, *Hydrocarbons, *Path of pollutants, *Data acquisition, *Monitoring, Measuring instruments, Vacuum extraction, Absorption, Measuring instruments.

Soil vapor surveying has been widely applied as a useful tool in assessing sites contaminated with volatile organic compounds. It is typically utilized only as an initial assessment tool to screen for site contamination and to aid in monitoring well placement. Careful planning and an understanding of vapor fate and transport theory can extend the utility of the data generated. The first step in conducting a soil vapor survey is to determine the appropriateness of the compounds spilled and the site for assessment by the vapor technique. Appropriateness of the site for vapor surveying rests in the logistical nature of the site, the character of the soil, the depth to bedrock, the water content of the soil, and the soil vertical heterogeneity. If, after making these determinations the site is judged to be a good candidate, target compounds are selected. At this point it is necessary to decide whether an active or passive approach is to be used. The active technique employs installation of probes on a predetermined sampling grid and extraction of soil vapor with a vacuum system. The passive approach employs deployment of hydrocarbon adsorber traps in flux chambers. The traps often consist of activated carbon; however, other materials can be used as site needs dictate. In many instances, when rapid response is required, data generated via a soil vapor survey can form the basis for the design and implementation of remediation systems. Prudent utilization of a soil vapor survey data can reduce the time between discovery of contamination and implementation of a remedial system. (See also W91-05236) (Lantz-PTT)
W91-05260

ASSESSMENT AND REMEDIATION OF RESIDENTIAL PROPERTIES CONTAMINATED WITH HOME HEATING OIL: CASE STUDIES.
Haley and Aldrich, Inc., Cambridge, MA.
For primary bibliographic entry see Field 5G.
W91-05262

CALIFORNIA LEAKING UNDERGROUND FUEL TANK FIELD MANUAL: A GUIDANCE DOCUMENT FOR ASSESSMENT OF UNDERGROUND FUEL LEAKS.
Orange County Health Care Agency, Santa Ana, CA.
For primary bibliographic entry see Field 5G.
W91-05265

LETTING THE SLEEPING DOG LIE: A CASE STUDY IN THE NO-ACTION REMEDIATION ALTERNATIVE FOR PETROLEUM CONTAMINATED SOILS.
Bank of America Environmental Services, Orange, CA.
For primary bibliographic entry see Field 5G.

W91-05266

COMPREHENSIVE ANALYSIS OF MIGRATION PATHWAYS (CAMP): CONTAMINANT MIGRATION PATHWAYS AT CONFINED DREDGED MATERIAL DISPOSAL FACILITIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
J. M. Brannon, J. C. Pennington, D. Gunnison, and T. E. Myers.
Available from the National Technical Information Service, Springfield, VA 22126361. Miscellaneous Paper D-90-5, September 1990. Final Report. 68p, 2 fig, 1 tab, 159 ref.

Descriptors: *Comprehensive Analysis of Migration Pathways, *Path of pollutants, *Dredging wastes, *Waste disposal, Waste management, Dikes, Leaching, Confined disposal, Volatile organic compounds.

A combined disposal facility (CDF) is a diked enclosure having either permeable or low-permeable walls that are used to retain dredged material solids. A framework for the analysis of contaminant migration, cycling, and mobilization pathways is being developed to integrate and assess the physical, chemical, and biological processes that occur in CDFs. The framework will use a tiered approach for estimating and predicting mass transport for contaminants in migration, cycling, and mobilization pathways. Key contaminant mobility processes and pathways operative in CDFs under varying operational and environmental conditions are documented and identified, along with information on models, assessment techniques, and areas for which insufficient information is available. Pathways involving the movement of large masses of water, such as CDF effluent, leaching through permeable dykes or through dredged material, have the greatest potential for moving significant quantities of contaminants out of the CDF. Pathways such as volatilization may also result in the movement of substantial amounts of volatile organic contaminants from CDFs. The relative importance of contaminant cycling and mobilization pathways to net mass balance has not been determined, but available information on each of the contaminant migration, cycling and mobilization pathways is summarized. Where possible, methods are provided for making rough estimates of contaminant mass movement via pathways. (Lantz-PTT)
W91-05269

GEOGRAPHIC INFORMATION SYSTEM DOCUMENTATION OF WATERSHED DATA FOR DIRECT/DELAYED RESPONSE PROJECT: SOUTHERN BLUE RIDGE PROVINCE DATABASE.
NSI Technology Services Corp., Corvallis, OR.
For primary bibliographic entry see Field 7C.
W91-05278

AGRICULTURAL CHEMICALS IN RURAL, PRIVATE WATER WELLS IN ILLINOIS: RECOMMENDATIONS FOR A STATEWIDE SURVEY.
Illinois State Geological Survey Div., Champaign.
D. P. McKenna, S. C. Schock, E. Mehnert, S. C. Mravik, and D. A. Keefer.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-223820. Price codes: A06 in paper copy, A01 in microfiche. 1989 Cooperative Groundwater Report 11, (1989). 100p, 95 fig, 94 tab, 59 ref, 6 append.

Descriptors: *Water pollution sources, *Agricultural chemicals, *Path of pollutants, *Illinois, *Wells, *Rural areas, *Surveys, *Groundwater pollution, Pesticides, Aquifers, Drinking water, Data acquisition, Decision making.

In Illinois, the concern over the potential for agricultural chemical contamination of groundwater is based on these facts: (1) Agricultural chemicals are extensively used--two out of three acres of rural Illinois are treated with pesticides; (2) Groundwater is the only source of drinking water in many rural areas; (3) Aquifers occur at shallow depths throughout the state--approximately 40% of the rural land is underlain by aquifers within 50 feet of the surface; (4) Pesticide contamination of groundwater has been found in other midwestern states. An initial effort is recommended to assess the extent of agricultural chemical contamination of groundwater in private wells, in rural areas of the state. The experimental design proposed will maximize the acquisition of data on the potential exposure of the rural population of Illinois to agricultural chemicals in drinking water. By sampling existing wells, this approach will minimize sample collection costs. Key elements of the experimental design are: (1) sample population defined as drilled, rural, private water supply wells, (2) recommended analytes based on use in Illinois and potential to contaminate groundwater, (3) stratified random sampling design using the potential for contamination of shallow aquifers as the stratification variable, (4) sampling plan for randomly selecting wells to sample within each of the strata, (5) characterization of well sites and identification of potential contamination sources, (6) well sampling schedule that addresses the potential for temporal variability in the occurrence of agricultural chemicals, (7) protocols for sample collection, (8) quality assurance/control procedures to ensure collection of high quality data, (9) recommendations for project organization and management. (Lantz-PTT)
W91-05280

IMPACTS OF METEOROLOGICAL VARIATIONS ON ACID RAIN ABATEMENT DECISIONS.
Waterloo Univ. (Ontario). Dept. of Systems Design Engineering.
K. Ponnambalam, E. A. McBean, and T. E. Unny.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1063-1075, November/December 1990. 6 fig, 4 tab, 13 ref.

Descriptors: *Environmental policy, *Water pollution sources, *Model studies, *Water quality management, *Acid rain, *Meteorological data, *Air pollution control, Linear programming, Industrial wastes, Sulfur compounds, Sulfur dioxide, Simulation analysis, Cost analysis, Sulfates, Canada.

Sulfur-based acid rain in eastern North America is caused primarily by the emissions from power and nonpower industries represented by 235 point 'controllable' sources and area pollution sources represented by 83 'noncontrollable' sources; in addition, there is a background deposition not accounted for by the emissions from these pollution sources. However, selection between strategies for reducing acidic deposition is an arduous task because of the numerous approaches and criteria that may be used to allocate reductions among SO2 emitters. A linear programming (LP) based simulation model was used to examine the effects of variable meteorology on optimal controls for acid-rain abatement in eastern North America. The LP model minimized the total cost of pollution control corresponding to the 235 controllable sources subject to satisfying the maximum acid deposition limits at 20 receptor locations. The meteorologic inputs were transformed into transfer coefficients relating emissions from sources to depositions at receptors. The meteorologic inputs varied from season to season and year to year, reflecting meteorologic uncertainty. The resulting optimal control strategies for five years of meteorologic data were used in a simulation model to develop a curve of control costs versus the cumulative violation of a critical deposition limit at the selected receptor locations in order to study the tradeoff between emission reduction cost and 'damage' reduction. It was shown that for the same total cost, the cumulative violations of the LP results are much better, i.e., a cumulative violation of about 5 kg wet sulfate instead of the about 26 kg wet sulfate over the critical limit for the five years achieved by a 50% across-the-board cut. As may be expected, each dollar invested is more effective at home-country (U.S. or Canada) receptors than at receptors in the neighboring country. (Fish-PTT)
W91-05321

GAS-TRANSFER MEASUREMENTS USING HEADSPACE ANALYSIS OF PROPANE.
Harza Engineering Co., Chicago, IL.
For primary bibliographic entry see Field 7B.
W91-05324

FATE AND TRANSPORT OF COMBINED RESIDUAL CHLORINE IN SMALL STREAM.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
D. A. Reckhow, D. W. Ostendorf, and M. E. Billa.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1125-1142, November/December 1990. 4 fig, 5 tab, 39 ref, 2 append. Massachusetts Division of Water Pollution Control Project No. 87-05.

Descriptors: *Environmental engineering, *Residual chlorine, *Fate of pollutants, *Path of pollutants, *Stream pollution, *Model studies, *Chlorination, Municipal wastewater, Wastewater management, Wastewater outfall, Water chemistry, Massachusetts.

Chlorination of municipal wastewater is widespread in the U.S., and most of this chlorine will react with ambient ammonia to form combined residual chlorine (CRC), i.e., monochloramine, dichloramine. The combined forms are relatively stable, persistent, and toxic to certain forms of aquatic life. Concentration profiles of CRC were measured in a small stream just below a municipal wastewater outfall (Lampson Brook in Belchertown, Massachusetts). Loss of CRC was found to be due primarily to volatilization. Vertical and longitudinal concentration profiles were successfully modeled with a two-dimensional diffusive transport model, not incorporating a stagnant film. To calibrate this model, a Henry's Law constant for CRC was determined in the laboratory. The model proved superior in the case studied to the classical two-film model for the prediction of depth-integrated combined residual chlorine. The diffusive transport model was nearly identical to the two-film model under conditions of imposed gas-phase limitation. However, the two-film theory predicted liquid-phase limitation for the data in this study, and as a result, significant differences existed between the two sets of model predictions. Field data clearly indicated gas-phase limitation, which was predicted by the two-dimensional diffusive transport model. (Fish-PTT)
W91-05325

DO MODEL UNCERTAINTY WITH CORRELATED INPUTS.
Nanjing Univ. (China). Dept. of Environmental Science.
Q. Song, and L. C. Brown.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1164-1180, November/December 1990. 3 fig, 9 tab, 10 ref, append. Environmental Protection Agency Cooperative Agreement No. 811883.

Descriptors: *Streamflow, *Model studies, *Uncertainty, *Dissolved oxygen, *Correlation analysis, Simulation analysis, Water quality management, Water pollution, Streeter-Phelps equation, Sensitivity analysis, Error analysis, *Monte Carlo method, Nitrification, Biological oxygen demand, Oxygen deficit.

In achieving effective environmental control, developing methodologies for dealing with uncertainties in model simulations of pollutant behavior and effects is important. Much of the uncertainty work has assumed that all input variables and parameters are mutually independent. The significance of correlation among the inputs on errors in model forecasts has not been closely examined in the past. The effect of correlation among the input parameters and variables on the output uncertainty of the Streeter-Phelps water-quality model was examined. Three uncertainty analysis techniques were used: sensitivity analysis, first-order error analysis, and Monte Carlo simulation. A modified version of the Streeter-Phelps model that includes nitrification, net algal oxygen production, and sediment oxygen demand was used. Analyses were

performed for a wide variety of simulated stream-flow conditions. Results showed that the standard deviation of the predicted dissolved oxygen deficit (DOD) with correlated inputs potentially can be 20-40% larger than with independent inputs. Under conditions of moderate to high velocity, the reaeration and bio-oxidation coefficients were the dominant contributors to DOD uncertainty, while net oxygen production from algal activity and sediment oxygen demand were the major factors at low velocity. The largest effect of input correlation on DOD occurred in the vicinity of the sag point. Uncertainty results from first-order analysis differed by at most 10% from those of a Monte Carlo simulation for both correlated and independent inputs. (Author's abstract)
W91-05327

TOXICITY ASSESSMENT BY POLLUTION-INDUCED COMMUNITY TOLERANCE (PICT), AND IDENTIFICATION OF METABOLITES IN PERIPHYTON COMMUNITIES AFTER EXPOSURE TO 4,5,6-TRICHLOROGUAIACOL.
Goeteborg Univ. (Sweden). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W91-05334

COPPER AND ZINC SORPTION ON SOME B HORIZONS OF QUEBEC SOILS.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
M. Duquette, and W. H. Hendershot.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 5/6, p 377-394, 1990. 2 fig, 4 tab, 28 ref. Natural Sciences and Engineering Research Council of Canada Grant A5822 and Conseil de Recherches et Services Agricoles du Quebec Grant MCA 85-C1176.

Descriptors: *Sorption, *Copper, *Zinc, *Soil horizons, *Soil solution, *Nutrient transport, Soil environment, Soil tests, Heavy metals, Hydrogen ion concentration, *Path of pollutants.

The sorption of copper (Cu) and zinc (Zn) on soils, as a function of pH, is important to an understanding of their mobility in the soil solution and their availability for plant nutrition. At high concentrations in the soil solution these elements can be toxic to plants. Copper and Zn sorption as a function of the pH were measured for six B horizons of two Orthic Humic Gleysols, tow Orthic Humo-Ferric Podzols, one Orthic Dystric Brunisol and one Orthic Sombric Brunisol. The results show that: 1) for the same amount of metal in solution and the same pH, more Cu is sorbed than Zn and 2) there is a maximum of sorption at or just above pH 5.00 and a large decrease as pH decreases. During the pH-dependent sorption of Cu and Zn on six B horizons of Quebec soils, it was found that ions were released into solution thus altering the charge generated by the soil at low pH and the sorption behavior of Cu and Zn. The solid phase most likely to control the level of ions in solution is believed to be the amorphous and oxide forms of Al and Fe. The dissolution of these metal oxide or hydrous oxide materials also releases cations adsorbed on, or occluded in, the amorphous material. (Author's abstract)
W91-05338

EFFECT OF SULPHUR DIOXIDE ON EXTRACTABLE MANGANESE IN SOILS.
La Trobe Univ., Bundoora (Australia). School of Agriculture.
N. C. Uren.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 5/6, p 429-438, 1990. 4 fig, 2 tab, 10 ref.

Descriptors: *Sulfur dioxide, *Sorption, *Soil chemistry, *Path of pollutants, *Manganese, Soil environment, *Soil water, Atomic absorption spectroscopy, Solubility, Peat, Lime, Chemical reduction.

The major factor affecting sulfur dioxide (SO2) sorption by soils is the moisture content, due to the high solubility of the gas in water. Samples of oven-dry soil, i.e. either clay soil from Kangaroo Ground or Toomuc sandy loam (Australia), were put in a desiccator. The desiccator was evacuated with a water pump and SO2 was introduced at a given pressure. After a given time the water soluble plus exchangeable manganese (extractable Mn) was extracted and analyzed for Mn by atomic absorption spectroscopy. Treatment of these soils with SO2 caused rapid increases in concentrations of water soluble plus exchangeable Mn. The extractable Mn increased with increasing pressure of SO2 and time of exposure, and increased with increasing water contents up to field capacity, but decreased beyond this point. The addition of peat to the sandy loam increased the effect of SO2 on extractable Mn while the addition of lime decreased the effect. Under the conditions of these experiments results illustrate that SO2 sorption rapidly leads to the reduction of Mn oxides and although the reductant is primarily SO2, in some soils the acidity which develops induces reduction by organic matter. Reactive Mn oxides in soils may contribute significantly to SO2 sorption by soils. (VerNooy-PTT)
W91-05339

EFFECTS OF LEACHING SURFACE-APPLIED AMENDMENTS ON SUBSOIL ALUMINUM AND ALFALFA GROWTH IN A LOUISIANA ULTISOL.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
B. W. Mathews, and R. E. Joost.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 7/8, p 567-581, 1990. 2 fig, 4 tab, 35 ref.

Descriptors: *Acid rain effects, *Toxicity, *Leaching, *Soil amendments, *Aluminum, *Alfalfa, *Subsoil, *Plant growth, *Path of pollutants, Loam, Soil contamination, Root development, Heavy metals, Soil solution.

Crop production on many soils of the southeastern USA is often severely restricted by subsoil aluminum (Al) toxicity, which retards root growth. Although alfalfa is normally deep-rooted, high levels of soluble Al in subsoils can reduce tap root elongation in this species. A greenhouse leaching column study was conducted to compare the effects of surface-applied langbeinite (LB), phosphogypsum (PG), calcium silicate slag (SS), and calcitic lime (CL) on subsoil Al and growth of alfalfa (Medicago sativa L. 'Florida 77') in Toula silt loam soil (Typic Fragiudult). Langbeinite was found to be more effective than PG in the reduction of subsoil exchangeable Al. It may play an important role in reducing subsoil exchangeable Al in Ultisols via precipitation of Al-hydroxy-sulfate minerals. The study demonstrated that high exchangeable Al levels are not always indicative of Al toxicity in the soil solution phase. The primary factors limiting alfalfa growth in the Toula soil were surface soil pH and manganese (Mn) toxicity rather than subsoil Al toxicity. The liming materials, SS and CL, effectively corrected the surface soil Mn and pH problems, but had no effect on subsoil chemical properties. Further research is needed to determine if leaching of LB followed by surface application of liming materials is of any greater benefit than surface liming alone for alfalfa root growth in subsoils with high Al levels. (VerNooy-PTT)
W91-05341

EQUATIONS TO CALCULATE THE APPROXIMATE DURATION AND TERMINATION OF THE MAXIMAL RATE PHASE OF NITRIFICATION IN SOIL.
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Soil Science.
D. J. Laubscher, J. M. van Zyl, and C. C. du Preez.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 7/8, p 611-621, 1990. 2 fig, 3 tab, 17 ref.

Descriptors: *Fate of pollutants, *Agricultural chemicals, *Model studies, *Mathematical models, *Nitrification, *Fertilizers, *Soil contamination, Soil amendments, Mathematical equations, Mathematical analysis, Ammonium, Kinetics, Model testing.

Increasing concern for the efficient use of nitrogen (N) fertilizer is being shown as the cost of crop production and the pollution of groundwater become critical factors in agriculture. It is therefore very important to be able to estimate the transformation rates (e.g., nitrification) of applied N in soils. Nitrification in soil is characterized by a sigmoidal curve with a delay, maximum rate and retarded phase. A model based on the Verhulst equation was used to describe all three phases of the nitrification process. Equations to calculate the maximum nitrification rate (K sub mx) and the delay period (T') exist already. Equations to calculate the approximate duration (delta T) and termination (t sub s) of the maximal rate phase were also derived from the Verhulst equation. The duration of maximal nitrification when ammonium ion (NH4(+)) is oxidized at a maximal rate is the period from the end of the delay period until the retarded phase starts. The termination of the maximal rate phase marks the approximate time when the retarded phase starts due to a depletion of NH4+. At this stage in the nitrification process additional NH4+ must be applied to prevent the minimum changes in the maximum nitrification rate of a soil. When first-order kinetics are used, the course of nitrification can consequently be described quantitatively by four parameters, K sub mx, t', delta t and t sub s. The equations were verified with experimental data from Clovelly and Dundee topsoils and subsoils. Similar parameters can also be calculated from experimental data of other biological reactions which are characterized by sigmoidal curves. (Author's abstract)
W91-05342

MARINE POLLUTION FROM LANDUSE IN THE PACIFIC ISLANDS REGION.
G. B. K. Baines, and R. J. Morrison.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 506-515, November 1990. 2 fig, 15 ref.

Descriptors: *Water pollution sources, *Pacific Islands, *Islands, *Marine pollution, *Land use, *Sediment discharge, *Coasts, Soil erosion, Erosion, Landslides, Tectonics, Tropical cyclones, Suspended sediments, Agricultural runoff, Water quality, Stream discharge.

With the single exception of Papua New Guinea, all land in the countries and territories of the Pacific islands region lies within the coastal zone. Both sediment and freshwater are land-derived substances that can give rise to a condition of marine pollution. Natural land changes include tectonic activity and cyclones with exceptionally heavy rainfalls leading to landslip activity. As a result, sediment and suspended matter constitute an important land-derived marine pollutant. The way in which forest removal influences material transfer from land to sea, sometimes to polluting levels, varies. Where the intensification of small-scale traditional agricultural is taking place, increased and sustained transfer of terrestrial sediment and freshwater to coastal waters is inevitable. Plantation agriculture and forestry should be less damaging to long-term hydrological and erosional behavior of watersheds than many other changes in land use. However, this situation may not be achieved without an extended period of significant disturbance to coastal waters. The massive excavation of surface and/or subsurface material which accompanies mineral development also poses problems for coastal waters. In addition, more sophisticated measures such as systems of water drainage control incorporating sediment traps and slope stabilization are needed to curb soil loss from road and construction in the region. National strategies for dealing with coastal water pollution originating from land use increasingly are being formulated in line with the South Pacific Regional Environment Programme (SPREP) Action Plan of 1982. Further research is needed to extend the development of ideas for improved land use in relation to maintenance of coastal water quality. Integrated studies on watersheds, catchments and the impact of runoff on the coastal environment are required. (VerNooy-PTT)
W91-05343

ESTIMATED INPUTS OF ORGANOCHLORINES FROM THE RIVER EBRO INTO THE NORTHWESTERN MEDITERRANEAN.
Centro de Investigacion y Desarrollo, Barcelona (Spain).
J. F. Cid Montanes, R. W. Risebrough, B. W. de Lappe, M. G. Marino, and J. Albaiges.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 518-523, November 1990. 2 fig, 3 tab, 22 ref.

Descriptors: *Water pollution sources, Nonpoint pollution sources, *Chlorinated hydrocarbons, *Polychlorinated biphenyls, *Ebro River, *Mediterranean, *Path of pollutants, *DDT, *Marine pollution, Pollution load, Halogenated pesticides, Stream pollution, Pollutant identification, Chemical analysis.

The Ebro River in northeastern Spain accounts for about 6% of all riverine waters entering into the Mediterranean Sea. Measurements of organochlorines in the particulate and dissolved phases of Ebro River water, sampled at the mouth at four periods over 1982-1983, are combined with data on daily flows to produce estimates of the inputs of these compounds into the northwestern Mediterranean from this source. Hexachlorobenzene (HCB) was the most abundant of the compounds detected, with an estimated yearly input of 30 kg, followed by polychlorinated biphenyls (PCBs), with a yearly input of about 12 kg. The HCB and PCBs are attributed principally to a manufacturing facility on the river. Other estimated yearly inputs are 8 kg of total DDTs, 1 kg each of dieldrin, endrin, and endosulfan, and 2 kg of chlordane compounds. Relatively high levels of p,p'-DDT among the DDT compounds indicated recent use or mobilization of DDT. These estimates of river inputs are substantially lower than those used or derived in several recent reviews of contamination problems in the Mediterranean. If the organochlorine concentrations reported here for the Ebro are typical of the majority of Mediterranean rivers, total input of organochlorines from rivers would be less than 2 tons. This is much less than a 1984 UNEP estimate of 90 tons/year. The estimates support conclusions of other studies that the principal dispersal pathway of the organochlorines is the atmosphere. (Author's abstract)
W91-05344

PCB AND PCT CONTAMINATION IN WINTER QUARTERS BAY, ANTARCTICA.
California Univ., Santa Cruz. Inst. of Marine Sciences.
R. W. Risebrough, B. W. de Lappe, and C. Younghans-Haug.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 523-529, November 1990. 6 fig, 1 tab, 22 ref.

Descriptors: *Water pollution sources, *Fate of pollutants, *Antarctic, *Polychlorinated biphenyls, *Polycyclic aromatic hydrocarbons, *Chlorinated hydrocarbons, *Path of pollutants, *Marine pollution, *Sediment contamination, Winter Quarters Bay, Waste dumps, Aroclors, Sediment sampler.

Polychlorinated biphenyls (PCBs) are likely contaminants in the vicinity of an antarctic base because of their presence in electrical equipment and many other materials used at the base. Winter Quarters Bay at McMurdo Station in Antarctica provides docking facilities to visiting ships and is adjacent to a former dump site. Sediments are heavily contaminated with a tarry material and contain a moderately high level of chlorinated biphenyls, in the range of 100 to 1400 nanograms/g dry weight. The composition in most samples is identical to that of Aroclor 1260, with no evidence of partial degradation, indicating a dominant point source of contamination. Chlorinated terphenyls (PCTs), also with a 60% chlorine composition, are present at levels in the order of 30 to 1200 nanograms/g. These amounts could have been disposed of at the former dump, or may have been derived from machine shop waste discharged with bilge waters into Winter Quarters Bay. Outside Winter Quarters Bay, PCB levels decrease sharply, by two orders of magnitude over 1 km, and four orders of magnitude at stations 9 and 15 km distant. A substantial modification of the congener composition is evident at the distant station, but the McMurdo PCB 'signature' nevertheless dominates over the 'global' signature characteristic of PCBs in the global atmospheric circulation. (Author's abstract)
W91-05345

METALS AND ORGANIC CONTAMINANTS IN NORTHWEST ATLANTIC DEEP-SEA TILEFISH TISSUES.
National Marine Fisheries Service, Highlands, NJ. Sandy Hook Lab.
F. W. Steimle, V. S. Zdanowicz, and D. F. Gadbois.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 530-535, November 1990. 2 fig, 4 tab, 22 ref.

Descriptors: *Bioaccumulation, *Tilefish, Marine fisheries, *Heavy metals, *Polycyclic aromatic hydrocarbons, *Polychlorinated biphenyls, *Halogenated pesticides, *Path of pollutants, *Atlantic Ocean, Tissue analysis, Animal tissues, Trace metals, Fish, Distribution patterns.

Tilefish are a large, benthophagous, demersal species usually found in sediment burrows within a restricted temperature-depth zone on the outer continental shelf and upper slope of the northwest Atlantic, from Nova Scotia to the Caribbean Sea. Data are presented on trace metal (silver, cadmium, chromium, copper, nickel, lead, and zinc) and organic hydrocarbons, i.e., polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and chlorinated pesticides, in tilefish. Chemical concentrations were determined in muscle, liver, gonad, and other tissues from two small 1981 to 1982 collections of tilefish (Lopholatilus chamaeleonticeps) from near Lydonia Canyon (on Georges Bank) and below Hudson Canyon (off New Jersey). Significant concentrations of trace metals and chlorinated hydrocarbons (PCBs and pesticides) were detected in the tissues, but these were generally within the ranges reported for other deep-sea and continental shelf fish in the Middle Atlantic Bight. Higher chlorinated hydrocarbon concentrations were detected in fish from the Lydonia Canyon area, compared with concentrations detected in the fish from below the Hudson Canyon. The difference appears to be statistically significant for most compounds and no satisfactory explanation can be suggested. (Author's abstract)
W91-05346

IMPACT ASSESSMENT FOR THE FRENCH NUCLEAR WEAPON TEST SITES IN FRENCH POLYNESIA.
Sydney Univ. (Australia). Ocean Sciences Inst.
J. Ribbe, and M. Tomczak.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 536-542, November 1990. 4 fig, 2 tab, 29 ref.

Descriptors: *Nuclear explosions, *Environmental impact, *French Polynesia, *Cesium radioisotopes, *Fallout, *Path of pollutants, Nuclear accidents, Moruroa Atoll, Foreign research, Hazard assessment, Marine pollution, Radioactivity, *Water pollution sources.

Nuclear weapon tests of the French government at the Moruroa Atoll in French Polynesia represent the largest producer of artificial radionuclides in the South Pacific region. Weapon testing began in 1966, followed by an underground testing program since 1974. A numerical dispersion model for cesium-137 data was used to elaborate an impact assessment for the French nuclear weapon testing site in French Polynesia. The three dimensional equation of advection/diffusion was solved by the Monte Carlo Technique. The mean transport field, isotropic horizontal and vertical turbulent exchange and radioactive decay were taken into consideration, but no biochemical processes were included. Over a period of 10 years the dispersion of the assumed radionuclide cesium-137 was monitored considering two different scenarios of its introduction into the marine environment. The first scenario or 'worst case', assumed a single release of the total radioactivity occurred which is currently stored in the interior of the Moruroa Atoll. For the second scenario a more likely and realistic case was studied: the venting of radioactive contaminated water from a constant source. The results of both scenarios are quite different in the farfield. However, in both cases the local environment of French Polynesia is the most affected. In the first scenario the loading during the first 3 to 4 years after the accident is more a result of a decreasing but very high activity concentration well above the background activity concentration of 3 to 4 Becquerels (Bq)/cu m, while in the 'realistic case' the loading is characterized by a nearly constant local activity concentration with values between 50 and 150 Bq/cu m. Only in the 'worst case' the western part of the South Pacific and its bordering countries are also affected by an activity concentration with a value higher than 80 Bq/cu m, i.e., well above the background noise. (VerNooy-PTT)
W91-05347

ORGANOCHLORINE COMPOUNDS IN THE PORTUGUESE OYSTER: IMPORTANCE OF SEASONAL VARIATIONS.
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
Castro, A. M. Ferreira, and C. Vale.
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 11, p 545-547, November 1990. 2 fig, 1 tab, 11 ref.

Descriptors: *Water pollution sources, *Agricultural chemicals, *Bioaccumulation, *Chlorinated hydrocarbons, *Halogenated pesticides, *Polychlorinated biphenyls, *Oysters, *Portugal, *Estuarine fisheries, Seasonal variation, DDT, DDE, DDD, Tissue analysis, Animal tissues, *Path of pollutants, Spawning.

Organochlorine concentration in oysters may vary geographically and seasonally. Spatial variability is normally interpreted as different contamination in the environment, whereas seasonal fluctuation may result from temporal changes in organochlorines in the environment as well as from lipid variations in the organism, which are generally related to the reproductive cycle. The seasonal variation of polychlorinated biphenyl (PCB) and DDT (p,p'-DDE + p,p'-DDD + p,p'-DDT) concentrations in whole soft tissue of the oyster, Crassostrea angulata, was studied. Oysters were collected at four stations along the upper Sado estuary (Portugal) from October 1985 to January 1987. Lipid concentrations remained normally below 5%, but in March and May values reached 14% and 12%, respectively. Concentrations of DDT ranged from 3 to 98 ng/g: high levels were recorded in January and March, decreasing to a minimum in July. Concentrations of PCB varied from 164 to 712 ng/g: the highest value was recorded in March, following a gradual decrease to July/September. Linear relationships between PCB and DDT concentrations, and lipid concentrations were found ($r=0.86$, $n=23$ and $r=0.75$, $n=22$ respectively, $p < 0.0001$). The gametogenesis-spawning cycle is important in the organochlorine uptake-release by bivalves. DDT and PCB concentrations in the remaining soft tissue of C. Angulata from the upper Sado Estuary tend to be more or less constant, except when dramatic changes occur in the environment. As the most important change in the upper estuary is runoff which occurs in winter--a pre-spawning period--the excess of organochlorines accumulated in the tissues is rapidly eliminated by subsequent spawning. (VerNooy-PTT)
W91-05348

NATURE AND MECHANISMS OF FORMATION OF METAL-HUMUS COMPLEXES.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05350

AIRBORNE TRACE METALS IN SNOW ON THE JAPAN SEA SIDE OF JAPAN.
Kanazawa Univ. (Japan). Dept. of Chemistry.
F.-J. Ecker, E. Hirai, and T. Chohji.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 10, p 2593-2600, 1990. 5 fig, 4 tab, 23 ref.

Descriptors: *Japan, *Trace metals, *Path of pollutants, *Snow, *Heavy metals, Meteorological

data collection, Aluminum, Cadmium, Chromium, Copper, Iron, Manganese, Lead, Zinc, Hydrogen ion concentration, Air pollution, Drinking water, Distribution patterns, Precipitation, Wet deposition.

In Japan, numerous field surveys have studied the chemical composition of wet and dry deposition intensively, especially within the industrialized areas along the Pacific coast. However, information is lacking for less-industrialized areas on the Japan Sea (west) side; such data are considered especially important in the analysis of long-range transport of airborne materials from the Asian continent. Prevailing seasonal weather patterns produce a homogeneous distribution of snow from the coast to the mountains in the Hokuriku region on the Japan Sea side of Japan. Daily snowfall was collected on polyethylene foils at six sites along the coast, in city areas and in the inland mountains. The samples were analyzed for pH and the soluble and insoluble fractions of Al, Cd, Cr, Cu, Fe, Mn, Pb, and Zn. The relative order of concentration of metals per volume snow was Fe > Al > Mn, Pb, Zn > Cu > Cd. Compared with data from other regions of the world, the concentrations found in wet-deposited snow in this study were rather low, even for the urban sites. Concentration levels of toxic elements such as Cd and Pb were found mostly to be within acceptable allowances for drinking water in Japan. The contribution of trace metals derived from sea spray and Kosa-loess particles was found to be of minor importance to the regional background. The pH values of melted snow averaged around 4.6 over a range of 3 pH units, with the greatest fluctuations at the seaside and mountain sites. In the cities, these pH fluctuations occurred within a narrower and generally lower pH spectrum. (Author's abstract)
W91-05355

MAJOR ELEMENT CHEMISTRY, DELTA-2-H, DELTA-18-O AND 87-SR/86-SR IN A SNOW PROFILE ACROSS CENTRAL SCANDINAVIA.
Stockholm Univ. (Sweden). Dept. of Geology.
P. Andersson, R. Lofvendahl, and G. Aberg.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 10, p 2601-2608, 1990. 4 fig, 3 tab, 25 ref.

Descriptors: *Scandinavia, *Snow, *Path of pollutants, *Air pollution, *Water pollution sources, *Radioisotopes, *Isotope studies, Trace metals, Precipitation, Strontium radioisotopes, Oxygen isotopes, Hydrogen isotopes, Seawater, Magnesium, Strontium, Chlorine, Sodium, Distribution patterns.

Snow in northern Scandinavia is well suited for the chemical analysis of natural and pollutive atmospheric deposition. In late February 1988, fresh snow was sampled at eight stations along a 450-km transect, spanning the Scandinavian Peninsula from the Atlantic Ocean in the west to the Gulf of Bothnia in the east. The elements Na, Mg, Ca, S, Cl, Sr, Al, Fe, Mn, and Zn were analyzed, and the nuclide pairs 87-Sr--86-Sr, 18-O--16-O, and 2-H--1-H measured. Concentrations of Na, Mg, Cl, and Sr were found to decrease rapidly with distance from the Atlantic coast. The other elements studied reflected more complicated patterns, caused by the addition of terrigenous matter and anthropogenic pollution. Stable oxygen and hydrogen isotopic compositions followed the general precipitation pattern, with values close to seawater in the west becoming isotopically progressively lighter eastward. The 87-Sr/86-Sr ratio in snow varied from 0.7098 near the Atlantic Ocean to 0.7194 at the easternmost station. Mixing calculations revealed that seawater contributes about 90% of the Sr at the westernmost stations, decreasing to 10-30% some 300 km eastward. Increases in the 87-Sr/86-Sr ratio inland are controlled by Sr fractions more radiogenic than seawater, but strongly heterogenous. The easternmost station was found to be strongly influenced by pollution, giving enhanced concentrations of S, Ca, and Sr and the highest 87-Sr/86-Sr ratio. (Fish-PTT)
W91-05356

SEASONAL VARIATION OF PERSISTENT ORGANOCHLORINE INSECTICIDE RESIDUES IN VELLAR RIVER WATERS IN TAMIL NADU, SOUTH INDIA.
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
A. Ramesh, S. Tanabe, H. Iwata, R. Tatsukawa, and A. N. Subramanian.
Environmental Pollution ENPOEK, Vol. 67, No. 4, p 289-304, 1990. 13 fig, 2 tab, 33 ref. International Scientific Research Programme of the Ministry of the Education, Science and Culture of Japan Projects 62042017 and 63041094.

Descriptors: *India, *Nonpoint pollution sources, *Organochlorine pesticides, *Path of pollutants, *Pesticide residues, *Pesticides, *Stream pollution, Benzene hexachloride, DDD, DDE, DDT, Mangrove swamps, Rice, Runoff, Seasonal variation, Vellar River, Water sampling.

Water samples collected from Vellar river and Pichavaram mangroves at Porto Novo (11 degrees 29' N, 79 degrees 46' E), Tamil Nadu State, South India, from December 1987 to January 1989 were analyzed to determine the seasonal variation of the levels of organochlorine insecticides such as HCH (BHC) and DDT. Both these insecticides showed higher levels from October to February, although this trend was more pronounced in HCH than DDT, reflecting the application of technical HCH largely and probably small quantities of DDT during the flowering season of rice. The alpha-HCH was detected as a dominant isomer for all seasons monitored followed by beta-HCH. Among DDT compounds, p,p'-DDT was highest in the river water except in the dry season when p,p'-DDD showed a higher percentage. On the other hand, in mangroves p,p'-DDE was highest during the wet season and p,p'-DDD during the dry season. Air-water partitioning data of HCH isomers and DDT compounds in Vellar river revealed that these chemicals tend to be in the water phase. These observations may aid in understanding the role of a tropical paddy area on the behavior and fate of man-made chemicals in view of worldwide contamination. (Author's abstract)
W91-05388

USE OF LYSIMETERS TO ESTIMATE LEACHING OF PESTICIDES IN AGRICULTURAL SOILS.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Water Management.
For primary bibliographic entry see Field 7B.
W91-05389

NUTRIENT AND SEDIMENT LOSSES FROM TURFGRASS.
Maryland Univ., College Park. Dept. of Agronomy.
C.M. Gross, J. S. Angle, and M. S. Welterlen.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 663-668, Oct-Dec 1990. 1 fig, 3 tab, 25 ref.

Descriptors: *Agricultural runoff, *Fertilizers, *Nonpoint pollution sources, *Sediment erosion, *Turf grasses, *Water pollution sources, Leaching, Nitrogen compounds, Nitrogen removal, Nutrient removal, Percolation, Plant growth, Runoff.

The contribution of turfgrass fertilizer to surface and groundwater pollution is not well documented. Two studies, at separate locations, were therefore initiated to examine losses of nutrients and sediment via leaching and runoff from turfgrass. Treatments included fertilizer applied in a liquid and granular form and an unfertilized control. Sodded tall fescue / Kentucky bluegrass plots were fertilized at a rate of 220 kg N per hectare per year in metered applications of urea. Runoff was collected and analyzed for volume, suspended and soluble solids, NH4-N, NO3-N, total N, PO4-P, total soluble P, and total P. Runoff losses of sediment and all nutrients were extremely low. Runoff losses of total N were significantly (p less than or equal to 0.05) higher when comparing the liquid and granular treatments to the control, although there was no difference between the fertilizer treatments. Losses for all forms of P and sediment did not differ significantly with regard to treatment. Soil percolate (0.75 m depth) was collected monthly from various treatments. Percolate NO3-N concentrations from the liquid and granular treatments did not differ significantly, although both were significantly higher than the untreated control. Soil cores (2.1 m depth) were collected every spring and fall in 0.30 m increments. Nitrate-N concentrations generally decreased with depth; however, the granular treatment exhibited higher soil NO3-N concentration than either liquid or control treatments. These results indicate that when compared with agronomic row crops, nutrient and sediment losses from turf via runoff, and leaching are very low. (Author's abstract)
W91-05396

TILLAGE EFFECTS ON SEDIMENT AND SOLUBLE NUTRIENT LOSSES FROM A MAURY SILT LOAM SOIL.
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
R. L. Blevins, W. W. Frye, P. L. Baldwin, and S. D. Robertson.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 683-686, Oct-Dec 1990. 5 tab, 23 ref.

Descriptors: *Agricultural practices, *Agricultural runoff, *Atrazine, *Loam, *Nonpoint pollution sources, *Nutrient transport, *Sediment erosion, *Tillage, *Water pollution sources, Corn, Nitrogen removal, Phosphorus removal, Surface runoff.

The contributions of three tillage systems used in corn (Zea mays) production with (i) sediment losses and surface runoff and (ii) the potential for nonpoint-source surface water pollution from N and P fertilizers and triazine herbicides were compared. Tillage treatments were no-tillage, chisel-plow tillage, and conventional tillage (moldboard plow plus secondary tillage). The study site was on a Maury silt loam. Over the 4 yr period, conventional tillage runoff volume was 576.7 kl/ha, chisel-plow 205.7 kl/ha, and no-tillage 239.9 kl/ha. Total soil loss from conventional tillage was 19.79 Mg/ha, chisel plow 0.71 Mg/ha, and no-tillage 0.55 Mg/ha. Amounts of NO3, soluble P, and atrazine leaving the plots in surface runoff were greatest from conventional tillage and about equal from chisel-plow and no-tillage. The magnitudes of losses in surface runoff water were small for all chemicals measured. (Doyle-PTT)
W91-05399

LEACHING OF CHLORSULFURON AND METSULFURON METHYL IN THREE SWEDISH SOILS MEASURED IN FIELD LYSIMETERS.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Water Management.
L. Bergstrom.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p701-706, Oct-Dec 1990. 2 fig, 4 tab, 24 ref.

Descriptors: *Herbicides, *Leaching, *Lysimeters, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Sweden, *Water pollution sources, Agricultural runoff, Chlorsulfuran, Metsulfuron, Percolation, Soil chemistry.

Leaching of the herbicides chlorsulfuron (2-chloro-N-(4-methoxy-6-methyl-1,3,5-triazin-yl) aminocarbonyl) benzene-sulfonamide) and metsulfuron methyl (methyl 2-(4-methoxy-6-methyl-1,3,5-triazin-2-yl) aminocarbonyl)-aminosulfonyl) benzoate) was studied using field lysimeters containing either undisturbed soil monoliths or packed soil. Three soil types were represented, two sandy soils and one clay soil. Each herbicide was applied at two rates, 4 and 8 g a.i./ha, representing normal and double doses of the compounds for spring cereals. All lysimeters received supplementary watering in addition to natural rainfall. With the exception of a single sample that had a chlorsulfuron concentration (14 ng/L) just above the detection limit, neither compound was detectible in leachate from lysimeters receiving the normal dose of the herbicides. For both herbicides at double dose, levels above the minimum detectible were found in selected lysimeters, reaching 43 and 21 ng/L for chlorsulfuron and metsulfuron methyl,

respectively. Converted to fluxes over the seven month period, considerably less than 1% of the applied chlorsulfuron and metsulfuron methyl appeared in the leachate. (Author's abstract)
W91-05401

EVALUATING PESTICIDE MIGRATION IN TILE-DRAINED SOILS WITH A TRANSFER FUNCTION MODEL.
Technische Univ. Braunschweig (Germany, F.R.). Abt. fuer Physische Geographie und Landschaftsoekologie.
J. Utermann, E. J. Kladivko, and W. A. Jury.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 707-714, Oct-Dec 1990. 5 fig, 4 tab, 23 ref.

Descriptors: *Model studies, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Soil contamination, *Solute transport, *Tile drainage, *Water pollution sources, Leaching, Probability distribution, Sensitivity analysis, Soil saturation, Traveltime, Water pollution prevention.

The interpretation and prediction of chemical outflow in tile drains as a result of solute migration through both unsaturated and saturated soil can be an important tool for understanding and reducing groundwater pollution risk. A simple analytical solution for predicting pesticide transport in tile-drained soils, based on the transfer function concept, is presented and tested in screening scenarios for chemicals with widely varying fate properties under different hypothetical transport characteristics for the individual soil layers. The inherent soil travel time variability of the two layers is embodied in probability density functions (pdf). The unsaturated zone is represented by either a unimodal or a bimodal pdf, the latter describing both preferential and matrix flow of solutes at the field scale. The saturated travel time pdf is derived from cumulative travel time distributions calculated by streamline functions. Sensitivity analysis focused on chemical outflow in tile drains as a function of travel time variability in the unsaturated and saturated soil, assuming linear equilibrium adsorption and first order decay in either the entire soil or the preferential and/or slow flow regions of the unsaturated soil, respectively. The tile drain outflow clearly reflects the time-delayed travel time characteristics of the unsaturated soil. Compared with a Gaussian-like pdf, a bimodal pdf for the unsaturated zone affects primarily the shortest travel times of highly retarded and short-lived chemicals. Screening scenarios with 10 different pesticides exhibit a strong influence of preferential flow on both the early arrival time in the tile and the total residual mass fraction, whereas the total residence time is nearly independent of travel time characteristics of the unsaturated soil. (Author's abstract)
W91-05402

MICROBIAL TRANSFORMATION OF 1,2-DIBROMO-3-CHLOROPROPANE (DBCP).
Cornell Univ., Ithaca, NY. Inst. for Comparative and Environmental Toxicology.
For primary bibliographic entry see Field 5G.
W91-05403

RESIDUAL EFFECT OF SEWAGE SLUDGE ON HEAVY METAL CONTENT OF TOBACCO AND PEANUT.
North Carolina State Univ. at Raleigh. Dept. of Soil Science.
L.D. King, and L. M. Hajjar.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 738-748, Oct-Dec 1990. 8 fig, 5 tab, 26 ref.

Descriptors: *Heavy metals, *Peanuts, *Sludge, *Sludge disposal, *Soil amendments, *Tobacco, *Water pollution sources, Crop rotation, Hydrogen ion concentration, Municipal wastewater, Regression analysis, Soil contamination.

The residual effect of sewage sludge in metal concentrations in tobacco and peanut was evaluated in a greenhouse pot experiment with a Typic Hapludult soil from a field that received aerobically digested municipal sewage sludge at 0, 9, 18, and 27 Mg/ha/yr for 3 yr. Cumulative amount of metals applied at the 27 Mg rate were (kg/ha) 1.8 Cd, 39 Cu, 48 Cr, 9 Ni, 30 Pb, and 84 Zn. Sulfuric acid or Ca(OH)2 was used to effect three soil pH regimes: 5.2, 5.8, and 6.4 (median value within each regime). Tobacco ('Speight G-28') was grown to flowering and peanut (NC 7) was grown to maturity. At the termination of the experiment, soils were extracted with diethylenetriaminopentaacetic acid (TPA) and Mehlich 3 extractant (M3) for metal analysis. Tobacco dry weight (averaged over pH) increased from 66 g/pot with no sludge to 94 g/pot at the highest sludge rate. Peanut kernel yield (averaged over pH) was depressed by sludge (probably as a result of Zn toxicity) and no kernels were formed at the medium and high rates. Sludge rates and soil pH had little effect on concentration of Cr and Pb in tobacco or peanut. Concentration of Cd, Ni, and Zn in tobacco and in peanut top growth decreased as soil pH increased to 5.8 to 6.0 but no decrease was noted at higher pH. Sludge rate effect was significant at low pH but diminished as pH increased. Concentration of Cd, Ni, and Zn declined but Cu concentration increased with increasing height of leaf on the tobacco stalk. Results of stepwise multiple regression using linear and quadratic forms of cumulative sludge rate, soil pH, and DTPA-extractable metals and pH X rate and pH X DTPA-extractable metals interactions as independent variables and metal concentration in the lower tobacco leaves or in peanut tops as dependent variables suggested DTPA would predict tissue metal concentrations better than would M3. (Doyle-PTT)
W91-05404

EFFECT OF DEICING SALTS ON TRACE METAL MOBILITY IN ROADSIDE SOILS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 4C.
W91-05408

MOBILIZATION OF COLLOIDS IN GROUNDWATER DUE TO INFILTRATION OF WATER AT A COAL ASH DISPOSAL SITE.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W91-05413

INFLUENCE OF MINERALOGY AND SOLUTION CHEMISTRY ON THE ATTACHMENT OF BACTERIA TO REPRESENTATIVE AQUIFER MATERIALS.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
M. A. Scholl, A. L. Mills, J. S. Herman, and G. M. Hornberger.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 321-336, December 1990. 4 fig, 1 tab, 33 ref.

Descriptors: *Aquatic bacteria, *Groundwater pollution, *Limestone, *Minerals, *Path of pollutants, Aquifers, Chemical properties, Hydrogen ion concentration, Muscovite, Porous media, Quartz, Water chemistry.

The rate and extent of bacterial attachment to mineral surfaces (chips of quartz, muscovite, limestone, and Fe-hydroxide-coated quartz and muscovite) was investigated by counting the numbers of bacterial cells (Lula-D, an indigenous groundwater organism) associated with each surface over time. The degree of attachment of cells to mineral surfaces was correlated with the sign of the surface charge as estimated from literature values for the isoelectric point; attachment of the negatively charged bacteria was much greater to the positively charged surfaces of limestone, Fe-hydroxide-coated quartz, and Fe-hydroxide-coated muscovite than to the negatively charged surfaces of clean quartz and clean muscovite. Batch experiments determined that the numbers of bacteria attached to clean muscovite increased with increasing ionic strength of the solution, and the numbers attached to clean quartz were greater at pH 5 than at pH 7. In columns of clean quartz sand under saturated flow conditions, bacteria initially broke through at 1 pore volume but continued to elute for at least 7 pore volumes. Columns of Fe-hydroxide-coated sand retained more of the bacteria added to the columns (99.9% vs. 97.4%), and elution of cells ceased after the primary breakthrough. The results indicate that surface interactions between the mineral grains in an aquifer and the bacterial cells must play an essential role in determining the movement of bacteria through saturated porous media. (Author's abstract)
W91-05414

INFLUENCE OF DETERGENT FORMULATION ON NUTRIENT MOVEMENT THROUGH SAND COLUMNS SIMULATING MOUND AND CONVENTIONAL SEPTIC SYSTEM DRAINFIELDS.
Geraghty and Miller, Inc., Raleigh, NC.
B. J. Alhajjar, C. L. Gould, G. Chesters, and J. M. Harkin.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 337-356, December 1990. 6 fig, 7 tab, 22 ref.

Descriptors: *Detergents, *Nitrogen, *Path of pollutants, *Phosphates, *Septic drain fields, *Septic tanks, *Soil disposal fields, Leachates, Leaching, Minerals, Phosphorus, Wastewater disposal, Zeolites.

The effects of phosphate (P) and zeolite (Z)-built detergents on leaching of N and P through sand columns simulating septic system drainfields were examined in laboratory columns. To simulate mound septic system drainfields, paired sets of columns were dosed intermittently with septic tank effluent from households using P-, or Z-built detergent. Two other paired sets of columns were flooded with P-, or Z-effluent to simulate new conventional septic system drainfields; after clogging mats or crusts developed at infiltration surfaces, the subsurfaces of the columns were aerated to simulate mature (crusted) conventional septic system drainfields. NO3 loading in leachate was 1.1 times higher and ortho-P loading was 4.3 times lower when columns were dosed with Z-than with P-effluent. Dosed columns removed P poorly; total phosphorus (TP) loading in leachate was 81 and 19 gm/sq m/yr with P-and Z-effluent, respectively. In flooded columns 1.3, 2.0 and 1.8 times more NH4, organic nitrogen (ON) and total nitrogen (TN) respectively, were leached with Z-than with P-effluent; NO3 leaching was similar. Flooded columns removed P efficiently; TP leached through flooded systems was 2.5 and 1.4 gm/sq m/yr with P-and Z effluent, respectively. Crusted columns fed Z-effluent leached 1.2, 2.6, 1.4 and 2.1 times more NH4, NO3, ON and TN, respectively, than those with P-effluent but 1.8 times less TP. Crusted columns removed P satisfactorily: 8.2 and 4.6 gm/sq m/yr TP with P-and Z-effluent, respectively. The P-built detergent substantially improves the efficiency of N removal with satisfactory P removal in columns simulating conventional septic system drainfields. Simultaneous removal of N and P under flooded conditions might be explained by precipitation of struvite-type minerals. Dosed system drainfields were less efficient in removing N and P compared to flooded and crusted system drainfields. (Author's abstract)
W91-05415

ESTIMATION OF ORGANIC CHEMICAL SORPTION BY SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
Z. Gerstl.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 357-375, December 1990. 4 fig, 9 tab, 36 ref.

Descriptors: *Organic carbon, *Organic compounds, *Path of pollutants, *Regression analysis, *Soil chemistry, *Sorption, Data collections, Organic matter, Physicochemical properties, Solubility, Statistical analysis, Structure-activity relationships.

Sorption data for over 400 compounds were collected from the scientific literature and analyzed to

provide accurate predictive equations for a chemical's behavior in the environment. Sorption coefficients on an organic carbon basis (Koc) were found to be log-normally distributed. Correlations between log Koc and log aqueous solubility (S), log Kow (octanol-water partition coefficient) and molecular connectivity (MC) indices were calculated and their predictive ability determined with a set of test data not included in the original data set. It was found that the equations (log Koc vs. either log S or log Kow) for individual chemical groups were preferred over the general equation for all chemicals but that a group correction term (Fc) added to the total equation gave similar results. The use of MC indices alone were inadequate for predicting sorption values with the exception of a few homologous groups. Another factor which makes this task difficult is the tremendous variability in the nature of methods used to determine sorption and the inherent variability of soils and soul organic matter. (Author's abstract)
W91-05416

VOLATILIZATION OF ORGANIC COMPOUNDS IN UNSATURATED POROUS MEDIA DURING INFILTRATION.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
H. J. Cho, and P. R. Jaffe.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 387-410, December 1990. 6 fig, 4 tab, 21 ref.

Descriptors: *Groundwater pollution, *Infiltration, *Mathematical models, *Model studies, *Path of pollutants, *Porous media, *Volatilization, Mass transfer, Numerical analysis, Organic solvents, Solute transport, Thermodynamics, Unsaturated flow.

A laboratory study was conducted to evaluate the validity of equilibrium assumptions for steady-state vapor-phase transport in homogeneous, well-packed porous media in the presence of water infiltration. The movement of a volatile, slightly water-soluble compound, trichlorethylene (TCE), was traced from a reservoir of solute dissolved in water, through a tension saturated zone and overlying unsaturated zone, to the soil surface. The experimental data and modeling results suggest that numerical models based on the assumption of thermodynamic equilibrium between the liquid-and gas-phase concentrations are inappropriate to describe this system. A model that assumes thermodynamic equilibrium between phases and uniform infiltration velocities predicts negligible gas-phase flux at any of the infiltration rates applied to the sand columns. Fluxes ranging from 0.046 micrograms/hr/sq cm for an infiltration rate of 0.210/cm to 0.006/micrograms/hr/sq cm for an infiltration rate of 1.34 cm/hr were observed. An equilibrium model adapted for a nonuniform velocity field, i.e. one that assumes all nonuniformities can be described by a dispersion coefficient, predicts that dissolved-phase dispersive phenomena will dominate solute transport of a slightly soluble compound in soils during infiltration. This dispersive transport acts counter to the average velocity field, and it is physically irrational that dispersion counter to the average flow is the predominant transport mechanism. A nonequilibrium model is proposed in which the infiltration flow regime is assumed to be nonuniform and the fluid phases are not assumed to be in equilibrium with each other. The method requires the knowledge of a gas-liquid mass-transfer coefficient for volatile compounds in a porous medium. Values of this mass-transfer coefficient have not been previously reported. (Author's abstract)
W91-05418

INTERFACIAL MIXING CAUSED BY TURBULENT BUOYANT JETS.
Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
For primary bibliographic entry see Field 8B.
W91-05419

MISCIBLE DISPLACEMENT WITH DENSITY AND VISCOSITY CONTRASTS. ESTIMATION OF DISPLACEMENT PARAMETERS AND STABILITY IN MECHANICAL DISPERSION REGIME (DEPLACEMENT MISCIBLE AVEC CONTRASTES DE DENSITE ET DE VISCOSITE EN MILIEU POREUX. IDENTIFICATION DES PARAMETRES DE DEPLACEMENT ET STABILITE EN REGIME DE DISPERSION MECANIQUE).
Strasbourg-1 Univ. (France).
M. A. Bues, and L. Zilliox.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 125-141, December 1990. 7 fig, 20 ref. (English summary).

Descriptors: *Aquifers, *Groundwater pollution, *Path of pollutants, Dispersion, Kinematic viscosity, Mathematical studies, Numerical analysis, Porosity, Porous media, Saline water.

The behavior and estimation of pollutant transport with water in an aquifer are based on the determination of displacement parameters (velocity field, dispersion tensor, kinematic porosity). The one-dimensional and isothermal displacement of two miscible fluids through an isotropic and homogeneous porous medium in mechanical dispersion were considered. An in situ measurement technique coupled with an impulse response method was used to verify the theoretical solution in the error function (trace case). With viscosity and density gradients, experimental and numerical (application of instability criterion) results were in good agreement. An asymptotic dispersion regime was shown for a quasi-stable displacement. The localization of a pollutant front in the studied configuration is discussed. (Author's abstract)
W91-05435

GEOCHEMICAL CALCULATIONS AND OBSERVATIONS ON SALT WATER INTRUSIONS: II. VALIDATION OF A GEOCHEMICAL MODEL WITH LABORATORY EXPERIMENTS.
Vrije Univ., Amsterdam (Netherlands). Inst. voor Aardwetenschappen.
For primary bibliographic entry see Field 2F.
W91-05440

CAESIUM DISTRIBUTION IN NORTHWEST MEDITERRANEAN SEAWATER, SUSPENDED PARTICLES AND SEDIMENTS.
Commissariat a l'Energie Atomique, La Seyne-sur-mer (France).
D. Calmet, and J. M. Fernandez.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 895-913, 1990. 7 fig, 3 tab, 63 ref.

Descriptors: *Cesium radioisotopes, *Fallout, *Gulf of Lions, *Mediterranean Sea, *Path of pollutants, *Sediment transport, *Sedimentation rates, *Suspended sediments, Chernobyl accident, Continental shelf, Deposition, Estuaries, Field methods, Heterogeneity, Marine environment, Mixing, Rhone Estuary, Runoff, Seawater, Sedimentation, Suspended solids, Tracers, Water column.

On account of cesium-134 and cesium-137 isotope content, Chernobyl fallout has been considered a useful single pulse input to study transport processes in the northwestern Mediterranean marine environment. Although the highest cesium values in seawater surface layers were observed in the Rhone estuary, across the whole Gulf of Lions the long distance impact of the Rhone releases (increased by continental runoff associated with the autumnal rains) has been demonstrated by using the existing discrepancy in the cesium 137/cesium 134 ratio for Chernobyl fallout, as opposed to the controlled authorized industrial liquid releases. The inventory in the water column after the Chernobyl accident, shows that the dissolved cesium-137 fraction is contained mainly in the upper layer with slow downward mixing. In the estuary, cesium-137 in seawater is subjected to high temporal, as well as vertical and horizontal spatial heterogeneity, with accumulation in the surface microlayer. The calculation of cesium fluxes is difficult without continuous records. The cesium-137 linked to suspended matter in the Rhone discharge is deposited rapidly on the continental shelf. No evidence exists that the Minor Rhone Canyon might be an active pathway for exported Rhone terrigenous sediment to the deep sea domain. In areas of intense sediment deposition, such as the Rhone estuary, the cesium-137/cesium-134 ratio can be used to estimate the present sedimentation rate; this rate can be up to 35 cm/year, in the area of abundant depositions. (Author's abstract)
W91-05453

FLUX OF TRANSURANIUM NUCLIDES AND CHLORINATED HYDROCARBONS IN THE NORTHWESTERN MEDITERRANEAN.
International Lab. of Marine Radioactivity, Monaco-Ville (Monaco).
S. W. Fowler, S. Ballestra, and J.-P. Villeneuve.
Continental Shelf Research CSHRDZ, Vol. 10, No. 9/11, p 1005-1023, 1990. 1 fig, 10 tab, 36 ref.

Descriptors: *Americium radioisotopes, *Chlorinated hydrocarbons, *Gulf of Lions, *Mediterranean Sea, *Path of pollutants, *Plutonium radioisotopes, *Sediment transport, Biogeochemical cycle, DDT, Fallout, Fate of pollutants, Particulate matter, Polychlorinated biphenyls, Residence time, Sediment sampler, Vertical flow, Water column.

The transuranium nuclides, plutonium and americium, and selected chlorinated hydrocarbon compounds have been measured in sediment trap samples, bottom sediments and waters. These measurements have been used to quantify vertical fluxes and elucidate particulate biogeochemical cycles, of these man-made contaminants in the northwestern Mediterranean. Sediment trap experiments in the Gulf of Lions (Lacaze-Duthiers Canyon) have shown that transuranic fluxes are considerably higher in the Gulf of Lions, than those which have been reported for the northeast Pacific, principally due to the relatively high mass fluxes in this region of the Mediterranean. Water, surface sediment and sediment trap data indicate that americium-241 is being transported downward (via particle settling) more rapidly than plutonium-239+240. From direct flux measurement, residence times for plutonium-239+240 and americium-241 in the upper 300 m were computed to be 2.5 and 0.14 years, respectively. Comparison of plutonium-239+240 concentrations in the water column, in 1986, with similar measurements made 5-11 years earlier suggests that fallout input to the Mediterranean has decreased by nearly a factor of 2 during the period from 1975 to 1986. Fluxes of PCB, HCB, gamma-HCH and DDT residues varied by as much as an order of magnitude, or more, both temporally and with depth. The average fluxes of most of the compounds in the Lacaze-Duthiers Canyon, during 1985 to 1986, were quite similar to those measured off the coast of Monaco several years earlier. Generally, the increased chlorinated hydrocarbon fluxes observed with depth were a direct result of the much higher mass fluxes which occurred with depth. Demonstrated differences in PCB concentrations in the settling particles, deposited surface sediments and overlying sediment floc indicate that simple bottom sediment resuspension is not a major contributor to the enhanced PCB flux. (Author's abstract)
W91-05457

CONTRIBUTION OF THE RHONE RIVER TO ORGANIC CARBON INPUTS TO THE NORTHWESTERN MEDITERRANEAN SEA.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
For primary bibliographic entry see Field 2J.
W91-05458

TRACERS AND CONSTITUENTS INDICATING THE NATURE OF ORGANIC FLUXES, THEIR ORIGIN AND THE EFFECT OF ENVIRONMENTAL CONDITIONS.
Perpignan Univ. (France). Lab. of Marine Sedimentalogy and Geochemistry.
For primary bibliographic entry see Field 2L.
W91-05459

BIOACCUMULATION OF MUTAGENS AND PROMUTAGENS IN FISH TAKEN FROM FOUR SITES IN NORTHEAST TENNESSEE.
East Tennessee State Univ., Johnson City. Dept. of Health Sciences.
For primary bibliographic entry see Field 5A.
W91-05462

EFFECT OF COMPETITION ON THE ADSORPTION OF SOME IONS (COPPER, ZINC, ZIRCONIUM, SELENIUM, AND STRONTIUM) ON RIVER-MUD.
Al-Najah National Univ., Nablus (Jordan). Dept. of Chemistry.
R. Salim, and K. Bloh.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 7, p 809-821, October 1989. 5 fig, 1 tab, 8 ref.

Descriptors: *Adsorption, *Competition, *Copper, *Mud, *Path of pollutants, *River sediments, *Selenium, *Strontium, *Zinc, *Zirconium, Adsorption kinetics, Heavy metals, Nickel, Sediment chemistry, Trace metals, Yttrium.

The effect of the presence of several competing ions on the adsorption process of copper, zinc, zirconium, selenium, and strontium in river mud was investigated, and the effect of the concentration of these competing ions on the competitive efficiencies was determined. The presence of competing ions is effective in reducing the adsorption efficiency of river mud towards a particular ion. Reduction of adsorption is dependent upon the concentration of competing ions. Zinc, zirconium, selenium, strontium, and yttrium ions can compete efficiently with copper ion adsorption on river mud. The competition efficiencies of these ions decrease in the order zirconium > strontium > selenium > yttrium > zinc. The ions of selenium, strontium, yttrium and nickel can compete with zinc adsorption efficiency on river mud; strontium, yttrium, and nickel ions can compete with selenium adsorption efficiency; yttrium and nickel ions can compete with strontium adsorption efficiency. (Brunone-PTT)
W91-05464

FRACTIONATION OF THE ORGANIC MATTER IN SOILS AND SEDIMENTS AND THEIR CONTRIBUTION TO THE SORPTION OF PESTICIDES.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
Z. Gerstl, and L. Kliger.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 6, p 729-741, 1990. 3 tab, 12 ref.

Descriptors: *Fate of pollutants, *Organic matter, *Path of pollutants, *Pesticides, *Sediment chemistry, *Soil chemistry, *Sorption, Cellulose, Herbicides, Hydrogen ion concentration, Napropamide, Separation techniques.

The organic matter of several soils and sediments was extracted by a gross fractionation procedure designed to dissolve specific classes of organic compounds. The sorption of napropamide, a nonionic herbicide, was measured on the original and extracted soils. Results showed that soils contained a higher percentage of cellulose and hemicellulose materials, while sediments contained a higher percentage of lipid-like fraction. Sorption of the test chemical was greater in the sediment, even on an organic basis, than in the soils. Removal of specific fractions slightly affected the organic carbon sorption coefficient of the sediments but not of the soils. Acid extraction resulted in large increases in sorption by both soils and sediments; this effect was only partially reversible upon readjusting the pH. (Author's abstract)
W91-05466

EFFECT OF VOLATILIZATION ON THE MASS FLOW OF A NON-AQUEOUS POLLUTANT LIQUID MIXTURE IN AN INERT POROUS MEDIUM: EXPERIMENTS WITH KEROSENE.
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
T. Galin, C. McDowell, and B. Yaron.
Journal of Soil Science JSSCAH, Vol. 41, No. 4, p 631-641, December 1990. 7 fig, 4 tab, 17 ref.

Descriptors: *Fate of pollutants, *Kerosene, *Path of pollutants, *Volatile organic compounds, *Volatilization, Groundwater pollution, Infiltration, Mass transport, Retention capacity, Saturated soils, Soil water, Viscosity.

Kerosene, an industrial petroleum product characterized by the presence of a large number of petroleum hydrocarbons (C9 to C15) was selected as an example of a non-aqueous pollutant liquid (NAPL) mixture for obtaining input parameters that could be used in modeling NAPL transport in a porous medium. Three inert materials (fine, medium, and coarse sand) were used in the experiments and the initial amount of kerosene applied ranged from residual to saturated retention capacity. Volatilization in the air phase and saturated mass flow of kerosene in the three sands were studied in the laboratory under controlled conditions. The volatilization was the major physico-chemical process affecting the fate of kerosene in the inert porous medium. During volatilization the liquid kerosene changed composition by gradually losing its light components, and the viscosity of the remaining liquid kerosene increased. The increase in viscosity led to a decrease in the infiltration rate, for example, by about 20% when the viscosity increased from .0013 to .002 Pa s. The relationship between the composition of the residual kerosene following volatilization and its mass flow in a sand illustrates the behavior of non-aqueous pollutants in nonporous media. (Author's abstract)
W91-05470

COMPARISON OF THE SURFACE IMPEDANCE FACTORS OF CA, NA, RB, AND CS DERIVED FROM THEIR SELF-DIFFUSION COEFFICIENTS IN VARIOUS SOILS.
Oxford Univ. (England). Soil Science Lab.
S. Staunton.
Journal of Soil Science JSSCAH, Vol. 41, No. 4, p 643-653, December 1990. 2 fig, 5 tab, 23 ref.

Descriptors: *Diffusion coefficient, *Impedance, *Path of pollutants, *Soil physical properties, *Soil water, Calcium, Cation exchange, Cesium, Distribution, Rubidium, Sodium, Trace minerals.

Self-diffusion coefficients of calcium, sodium, rubidium and cesium on the topsoils and subsoils of contrasting soil series were determined. The distribution ratios of each cation on each soil, at the moisture content of the diffusion experiments, have been calculated by extrapolation from series of suspensions. Diffusion coefficients were found in each case to be greater than expected by considering the liquid phase alone. Surface-phase impedance factors (f) were calculated. Although impedance factors are considerably smaller on the surface than in solution, the surface flux may exceed the flux in the liquid phase. Differences of an order of magnitude separated average values of f for each cation. For a given cation, variations between soils were considerably less. No correlation was found between f and soil mineralogy or composition. Values of f were found to decrease with increasing distribution ratio. A comparison of the relative values of f for these cations suggests that considerable demixing occurs on the soil surface, and that the various adsorbed species of any cation in a given system may have differing mobilities. (Author's abstract)
W91-05471

RETARDED LEACHING OF NITRATE IN ACID SOILS FROM THE TROPICS: MEASUREMENT OF THE EFFECTIVE ANION EXCHANGE CAPACITY.
Reading Univ. (England). Dept. of Soil Science.
M. T. F. Wong, R. Hughes, and D. L. Rowell.
Journal of Soil Science JSSCAH, Vol. 41, No. 4, p 655-663, December 1990. 2 fig, 3 tab, 24 ref.

Descriptors: *Acidic soils, *Anion exchange, *Laboratory methods, *Leaching, *Nitrates, *Path of pollutants, *Soil chemistry, *Soil columns, *Tropical regions, Ammonium chloride, Hydrogen ion concentration, Soil types, Sulfates, Water pollution sources.

Delay in the leaching of nitrate was measured in laboratory columns of repacked soils (Oxisols, Alfisols, Ultisols, and Inceptisols) from South America, Africa, and southeast Asia. Between one and five pore volumes were required for the frontal displacement of chloride by nitrate (2 mM adjusted to the natural pH of the soil). The delay was in good agreement with that calculated from charge (0 to 1.7 cmol positive charge/kg). Measurement of charge by batch equilibration with 0.5 M and then 2 mM ammonium chloride at the pH of the soil overestimated the effective charge, probably due to the removal of sulfate in the washings. A leaching method using only 2 mM ammonium chloride gave a better estimation. (Author's abstract)
W91-05472

ASPECTS OF TRANSPORT PROCESSES IN AGGREGATED SOILS.
Silsoe Coll. (England).
E. G. Youngs, and P. B. Leeds-Harrison.
Journal of Soil Science JSSCAH, Vol. 41, No. 4, p 665-675, December 1990. 2 fig, 26 ref, 3 append.

Descriptors: *Path of pollutants, *Soil aggregates, *Soil porosity, *Solute transport, Aggregates, Boundary conditions, Drainage, Leaching, Macropores, Mathematical models, Saturated soils, Soil physical properties, Solutes.

The way in which water and solutes move in aggregated soils depends on the mode of saturation of the pore space that is made up of the micropore region within the aggregates and the macropores surrounding them. When both regions are saturated, a hydraulic-head gradient causes water to flow preferentially in the macropores with little flow within the aggregates, so that movement of solutes in or out of the aggregates is mainly by diffusion caused by the difference between the solute concentrations of the water in the two regions. When macropores full of water surround unsaturated aggregates, water is imbibed by the aggregates, giving rise to convective movement of solutes with the moving water. When the macropores are empty, the aggregates become almost isolated so that redistribution of water and solutes occurs only within the aggregates with very little transport of water and solutes between them. The movement of water and solutes in the micropore region within the aggregates can be considered to behave as if in a continuum, and can be described by Darcy's law and the dispersion equation, with boundary conditions imposed by conditions in the macropores. These physical considerations of transport behavior in aggregated soils can be used to give guidance in soil management practices concerning drainage and leaching. (Author's abstract)
W91-05473

HEAVY-METAL UPTAKE FROM THE FREIBURG WASTEWATER FIELD BY GARDEN VEGETABLES (SCHWERMETALLAUFNAHME VON GARTENPFLANZEN DER FREIBURGER RIESELFELDER).
Freiburg Univ. (Germany, F.R.). Inst. fuer Bodenkunde und Waldrnaehrungslehre.
For primary bibliographic entry see Field 5E.
W91-05474

CADMIUM ADSORPTION BY SEWAGE SLUDGE-TREATED SOIL AFTER DIFFERENT WETTING AND DRY CYCLES.
Akademia Techniczno-Rolnicza, Bydgoszcz (Poland).
For primary bibliographic entry see Field 5E.
W91-05479

ABSORPTION OF HERBICIDES BY SOILS OF THE CAMPANIA REGION (ADSORBIMENTO DI DISERBANTI SU SUOLI DELLA CAMPANIA).
Naples Univ. (Italy). Ist. di Chimica Agraria.

G. Basile, M. Arienzo, and G. Celano.
Agrochimica AGRCAX, Vol. 34, No. 3, p 181-192, May/June 1990. 5 fig, 6 tab, 6 ref. English summary.

Descriptors: *Herbicides, *Italy, *Path of pollutants, *Soils, *Triazine herbicides, Absorption, Atrazine, Clays, Paraquat, Simazine, Soil organic matter.

The environmental behavior of Atrazine, Simazine, Trifluralin, Linuron and Paraquat on some soils of the Campania region was studied. The adsorption coefficients showed the order of adsorption to be as follows: trifluralin > paraquat > linuron > atrazine > simazine. It is evident from the adsorption coefficient that s-triazines are almost solely adsorbed by organic matter. The adsorption coefficient also indicated the role of clays in the immobilization of trifluralin and paraquat on clay soils in Battipaglia and Castelvolturno. Finally, the weak adsorption of paraquat by sandy soils in the Vesuvius region suggests a greater probability of photochemical degradation phenomena and of residual action. (Author's abstract)
W91-05482

IONIC TRACER MOVEMENT THROUGH A WYOMING SNOWPACK.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
R. C. Bales, A. Sommerfeld, and D. G. Kebler.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 11, p 2749-2758, 1990. 7 fig, 2 tab, 20 ref. USDA Forest Service cooperative agreement 28-C8-461 with the University of Arizona.

Descriptors: *Acid rain, *Ion transport, *Ions, *Path of pollutants, *Snow cover, *Snowpack, *Tracers, *Water pollution sources, *Wyoming, Chemical properties, Ice, Lysimeters, Melting, Moisture meters, Physical properties, Silica, Water.

The movement of ionic species through a well-characterized shallow snowpack in the field was investigated. The experimental work involved adding chemical tracers to amplify the chemical signal in snow, then making point measurements of the magnitude and timing of the ionic pulse using snow pits and lysimeters. The water and ionic flux measurements were then related to the physical and chemical properties of the snowpack during both the accumulation and melt seasons. A meltwater ionic pulse with initial concentrations of 5-10 or more times the average was observed in lysimeters set at the base of a 2-m snowpack in an unpolluted, alpine watershed. Both background chemical species and added tracers exhibited the initial pulse. About ten days after the onset of meltwater release, solute concentrations collected in the lysimeters dropped to near the average snowpack level. Silica was elevated more than major ions in some initial lysimeter samples, which is evidence of a soil-water or overland-flow contribution. Lysimeter flow rates were equivalent to about 2 cm of melted snow per day, approximately equal to the daily melt estimated from a temperature-index model. Less than 10 percent of the ionic-tracer mass applied to snow directly above the lysimeters was present in the meltwater. Snow pits dug in an area adjacent to the lysimeters showed that ice lenses played a significant role in solute movement through the pack, influencing both solute depletion and horizontal vs vertical flow. Snow pits also showed depletion of at least 25-35 percent of the solute mass during release of the first 10 percent of meltwater. (Author's abstract)
W91-05490

ATMOSPHERIC POLLUTANT DEPOSITION TO HIGH ELEVATION ECOSYSTEMS.
Institute of Ecosystem Studies, Millbrook, NY.
G. M. Lovett, and J. D. Kinsman.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 11, p 2767-2786, 1990. 4 fig, 4 tab, 132 ref. Integrated Forest Study of the Electric Power Research Institute Project RP-2621 through Oak Ridge National Laboratory.

Descriptors: *Acid rain, *Acid rain effects, *Air pollution effects, *Chemistry of precipitation, *Deposition, *Forest ecosystems, *Mountains, *North America, *Path of pollutants, *Pollutants, Clouds, Elevation, Heavy metals, Hydrogen ion concentration, Lead, Nitrates, Orography, Reviews, Seasonal variation, Variability, Vegetation, Wind velocity.

Current knowledge regarding deposition of atmospheric pollutants to mountain ecosystems is reviewed, focusing on the mountains of Eastern North america. Despite a general paucity of published data on the subject, some generalizations emerge. Wet deposition (i.e. precipitation input) of SO4(2-), NO3(-), H(+) and Pb tends to increase with elevation, primarily because of the orographic increase in precipitation amount. Cloud water deposition of these substances can be significant for mountain forests, but is highly variable spatially because of its strong dependence on wind speed, cloud characteristics, and vegetation canopy structure, which are all heterogeneously distributed. Dry deposition has not been quantified sufficiently to draw empirical generalizations, but the processes involved are discussed with regard to expected elevational trends. Based on the few studies in which total annual deposition (dry, wet, plus cloud water inputs for an entire year) has been measured, it appears that some high-elevation sites in the Appalachian Mountains receive substantially more SO4(2-), NO3(-) and H(+) deposition than do typical low-elevation sites. The amount of elevational increase depends largely on the amount of cloud water deposition at the mountain site. Data from two clusters of sites in the northern Appalachians indicate that total deposition of SO4(2-), NO3(-), and H(+) to mountaintop sites is typically 3-7 times greater than deposition to nearby lowland sites. Similarly, some studies of Pb accumulation in organic soil horizons suggest a two to four-fold increase from lowlands to mountaintops. Night and early morning O3 concentrations are greater at high-elevation than at low-elevation sites. Daytime O3 levels are equal or slightly higher at high-elevations. (Author's abstract)
W91-05491

INFLUENCE OF SEA SALT AEROSOLS AND LONG RANGE TRANSPORT ON PRECIPITATION CHEMISTRY AT EL VERDE, PUERTO RICO.
State Univ. of New York Coll. at Oswego. Research Center.
W. H. McDowell, C. Gines Sanchez, C. E. Asbury, and C. R. Ramos Perez.
Atmospheric Environment Part A: General Topics AEATEN, Vol. 24, No. 11, p 2813-2821, 1990. 4 fig, 5 tab, 48 ref. U.S. Department of Energy Contract DE-AC05-760R01833.

Descriptors: *Acid rain, *Air pollution sources, *Chemistry of precipitation, *Marine climates, *Puerto Rico, *Sea breezes, *Seawater, *Water pollution sources, Aerosol transport, Aerosols, Air pollution, Forests, Hydrogen ion concentration, Ions, Nutrients, Rain forests, Seasonal variation, Statistical analysis.

The role of precipitation in nutrient cycles in the Caribbean National Forest was documented. This was done by (1) describing the chemistry of precipitation; (2) quantifying deposition to the rain forest; and (3) attempting to identify the sources of the principal ions in precipitation. The chemistry of bulk precipitation was measured from November 1983 to September 1987 at El Verde in the Luquillo Experimental Forest, Puerto Rico. Wet-only precipitation was also analyzed as part of the National Atmospheric Deposition Program from 1984 to 1987. Volume-weighted mean pH was 5.14 in bulk precipitation and 5.12 in wet precipitation. Concentrations of most species were correlated negatively with weekly rainfall. Sea salt aerosols contributed most of the Na(+), Cl(-), Mg(2+) and K(+) found in wet and bulk precipitation; sulfate and calcium, however, were derived primarily from non-sea salt sources. Due to the high rainfall (3.4 m annually during the study period) and close proximity of the study site to the ocean, deposition rates of the major cations and anions were high relative to many other tropical sites. Precipitation chemistry at El Verde appears to be affected by several factors. During summer, Saharan dusts contribute a significant portion of the excess Ca(2+), K(+) and Mg(2+). During winter months, cold fronts may transport SO4(2-) and NO3(-) from North America and the western part of Puerto Rico to the sampling site. (Author's abstract)
W91-05492

MOVEMENT OF SALTS IN SOIL IRRIGATED WITH LOW AND HIGH CONDUCTIVITY WATERS.
Incitec Ltd., Morningside (Australia).
For primary bibliographic entry see Field 3C.
W91-05561

239, 240-PU AND 137-CS CONCENTRATIONS IN SOME MARINE ORGANISMS, MOSTLY FROM THE IBARAKI AND AOMORI COASTS, JAPAN, 1987-1989.
National Inst. of Radiological Sciences, Nakaminato (Japan). Div. of Marine Radioecology.
Y. Nagaya, Y. Suzuki, and K. Nakamura.
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 10, p 1599-1604, October 1990. 1 fig, 6 tab, 16 ref.

Descriptors: *Aomori, *Bioaccumulation, *Cesium radioisotopes, *Coastal waters, *Ibaraki, *Japan, *Path of pollutants, *Plutonium radioisotopes, *Radioisotopes, Benthic environment, Fish, Pollutant identification, Radioactivity, Regional variation, Tissue analysis.

An effort has been made to clarify the discrepancies in the radionuclide contents among regions, tissues and species from two coastal regions of Japan. Several marine biological samples were collected from the Pacific coasts of Ibaraki and Aomori Prefecture in 1987 to 1989, and 137-Cs concentrations were measured. The radionuclides of some pelagic and benthic fish were also measured to make comparisons with coastal species. 239-Pu and 240-Pu contents of coastal fish were higher in the viscera, while muscle tissue usually had the lowest values. In contrast, 137-Cs values were somewhat higher in the muscle. Differences in radionuclide concentrations were found among species, but no definite regional variation was observed between the Ibaraki and Aomori coasts. This suggests a similar radioactive pollution level along the Pacific coast of northern Japan. The 239-Pu and 240-Pu concentration level in coastal fish was higher than that in pelagic ones, and no significant difference was observed between pelagic fish from warm water masses and cold water masses. On the contrary, there was a clear difference in the 137-Cs content of pelagic fish between warm water species and cold water species. The surface and benthic fish seemed to have similar concentration levels of radionuclides. The concentration of radionuclides in marine organisms seems to be controlled by both the biological affinity and the physicochemical state of the isotopes in sea water. Most of the 137-Cs is reportedly in a dissolved state in sea water and transported with water movement, whereas considerable portions of Pu isotopes are reported to be in particulate form. The general tendencies of radionuclide distribution in fish were probably caused by the difference in the physicochemical form of the radionuclides. (Agostine-PTT)
W91-05573

POLYCYCLIC AROMATIC HYDROCARBONS IN LEACHED CHERNOZEMS AND GRAY FOREST SOILS OF NATURAL AND TECHNOGENIC LANDSCAPES.
Moscow State Univ. (USSR). Faculty of Geography.
Y. M. Nikiforova, I. S. Kozin, T. A. Teplitskaya, and K. Tsird.
Soviet Soil Science SSSCAE, Vol. 21, No. 3, p 53-61, 1989. 2 fig, 1 tab, 20 ref. Translated from: Pochrovedeniye, 1989, No. 20:70-78.

Descriptors: *Forest soils, *Industrial wastes, *Leachates, *Path of pollutants, *Polycyclic aromatic hydrocarbons, *Soil formation, *Tracers, *USSR, *Weathering, Fluorometry, Geochemistry, Organic compounds, Pollutant identification, Soil contamination.

Certain of the most widespread polycyclic aromatic hydrocarbons (PAH's) were studied in the soils of a large industrial city in the forest steppe zone of the trans-Volga region. The soils are polluted with technogenic emissions from a synthetic rubber plant. Data from field soil-geochemical investigations made in June 1985 were analyzed using unpolluted soils developing in analogous landscapes, but free of technogenic influences were also studied, as a reference. Fine-structure spectrofluorometry was used to study the composition, concentration and distributions of various individual PAH structures in reference and polluted soils. It was concluded that the PAH's may be used as geochemical indicators of natural soil formation processes and secondary or superimposed trends of technopedogenesis. The natural transformation of the organic matter of leached Chernozems and Dark Gray Forest soils, and their natural evolution in the forest steppe landscapes of the trans-Volga region, is accompanied by the formation of 'angular' low molecular weight phenanthrene structures among the PAH's. The detection of condensed structures with 4 to 7 rings among the polyarenes of reference soils indicates the presence of a regional and global geochemical PAH reference. The pronounced accumulation of 4-7 ring polyarenes in the surface horizons of urban soils expresses the composition and strength of local technogenic PAH anomalies, which pose a direct danger to the health of the population. The considerable decrease in the concentration of 'biogenic' molecules in the presence of urban pollution is balanced by an increase in the concentration of anthropogenic molecules. (Agostine-PTT)
W91-05575

ALKALINITIES OF MAINE LAKES: ARE THEY REALLY CHANGING.
Maine Univ., Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2H.
W91-05579

PHOSPHATE UPTAKE ALONG A COASTAL PLAIN ESTUARY.
Delaware Univ., Lewes. Coll. of Marine Studies.
M. E. Lebo.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1279-1289, September 1990. 8 fig, 38 ref. NSF Grant OCE-86-01616, NOAA Sea Grant NA86AA-D-SG040.

Descriptors: *Cycling nutrients, *Delaware River Estuary, *Estuaries, *Nutrients, *Path of pollutants, *Phosphates, Algal physiology, Bacteria, Bacterial physiology, Competition, Phytoplankton, Seasonal variation, Spatial distribution, Suspended sediments, Tidal rivers.

Biotic PO4(3-) uptake rates were measured along the Delaware estuary to examine seasonal and spatial patterns of variation. Uptake was highest (40 to 90 nmol/L/h) in summer and lowest (<10 nmol/L/h) in winter. The highest rates of PO4(3-) uptake were measured in the tidal and the lower bay, the concentration of suspended sediment is high, and PO4(3-) uptake was reduced (<5nmol/L/h) at all times of the year. Partitioning of uptake by size revealed that both bacteria and phytoplankton are important in the uptake of PO4(3-) throughout the estuary. The proportion of uptake by bacteria, however, changed spatially. In the tidal river where anthropogenic inputs are high, bacteria dominated PO4(3-) uptake and accounted for up to 70% of the total. Within the salinity gradient of the estuary, the proportion of bacterial uptake was much lower, with bacteria accounting for only 15 to 25% of PO4(3-) uptake. The competition between bacteria and phytoplankton for PO4(3-) was affected by anthropogenic inputs into the tidal river. (Author's abstract)
W91-05580

GROUND-WATER POLLUTION RISK ASSESSMENT FOR PUBLIC WATER SUPPLY SOURCES IN BARBADOS.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
For primary bibliographic entry see Field 2F.
W91-05639

ASPECTS OF THE HYDROGEOLOGY OF THE NORTHWEST REGION, YUCATAN PENINSULA, MEXICO.
Northern Illinois Univ., De Kalb. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-05647

WATER QUALITY OF A CARBONATE ISLAND KARST AQUIFER, SAN SALVADOR ISLAND, BAHAMAS.
Mississippi State Univ., Mississippi State. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2F.
W91-05654

BASELINE WATER-QUALITY EVALUATION OF THREE BASINS IN THE UPPER RIO GRANDE DE ARECIBO BASIN, PUERTO RICO.
Geological Survey, Denver, CO. Water Resources Div.
P. W. McKinley.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 433-441, 2 fig, 4 tab, 11 ref.

Descriptors: *Baseline studies, *Copper, *Mining effects, *Puerto Rico, *Rio Grande de Arecibo Basin, *Tropical hydrology, *Water chemistry, *Water quality, Bicarbonates, Calcium, Hydrogen ion concentration, Monitoring, Rio Pellejas, Rio Tanama, Rio Vivi, River basins, Sulfates, Suspended sediments.

The upper Rio Grande de Arecibo basin contains undeveloped copper ore deposits in the Rios Pellejas, Vivi, and Tanama drainage basins. Baseline water quality data are needed to monitor water quality as economic development comes to the upper Rio Grande de Arecibo basin. Dissolved sulfate at Rios Pellejas and Vivi averages over 44 mg/L, whereas at Rio Tanama, the average concentration is 12.4 mg/L. Dissolved calcium represents about 50% of the dissolved cations in all three basins. Water from the Rio Tanama basin is best described as calcium bicarbonate. The specific conductance for the three basins is in the 150 to 250 microsiemens/cm range, and the pH normally is between 7 and 8 units. Dissolved copper concentrations of samples from Rio Tanama averaged 7.2 micrograms/L. The average annual suspended sediment yield for Rio Vivi was 760 Mgm/sq km/yr, and for Rio Tanama, 1,090 Mgm/sq km/yr. (See also W91-05611) (Author's abstract)
W91-05655

LAND DEVELOPMENT AND WATER QUALITY: THE CAYMAN ISLANDS STUDY.
Tennessee Univ., Knoxville.
For primary bibliographic entry see Field 4C.
W91-05656

FATE OF MEVINPHOS SPILL AND WATER QUALITY: A CASE STUDY FROM LAKES PEN MUNICIPAL DUMP.
Underground Water Authority, Kingston (Jamaica).
P. Lamm.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 475-484, 8 fig, 20 ref.

Descriptors: *Fate of pollutants, *Insecticides, *Mevinphos, *Organophosphorus pesticides, *Path of pollutants, *Pesticides, *Tropical hydrology, *Water pollution effects, Cleanup operations, Groundwater quality, Jamaica, Lakes Pen, Phosdrin, Potable water, Spills.

The uncontrolled spill of 237 gallons of poisonous Phosdrin organo-phosphate insecticide at Lakes Pen resulted in 3 human casualties. Through prompt diagnosis, all three recovered completely. Remedial clean-up and disposal of Mevinphos was followed by soil and water quality studies to determine the extent of contamination. Analytic results showed effective degradation of Mevinphos in soil, and no contamination of groundwater. Changes observed in groundwater chemistry at Lakes Pen were gradual, controlled by travel distance and time in the alluvium aquifer. Both groundwater and surface-water quality appeared independent of dump operations at Lakes Pen, and conformed to WHO Inorganic Potable Water Guidelines. (See also W91-05611) (Author's abstract)
W91-05659

USE OF ADSORBED AND NON-ADSORBED TRACERS TO STUDY THE TRANSPORT OF AGRICULTURAL CHEMICALS TO SHALLOW GROUNDWATER.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
R. S. Kanwar, C. J. Everts, and G. F. Czapar.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 485-494, 8 fig, 24 ref.

Descriptors: *Agricultural chemicals, *Environmental tracers, *Groundwater pollution, *Herbicides, *Path of pollutants, *Tracers, *Tropical hydrology, Alachlor, Anions, Bromides, Cations, Chlorides, Cyanazine, Dye releases, Leaching, Lithium, Nitrates, Rhodamine, Simulated rainfall.

Field experiments were conducted in 1987, 1988, and 1989 at Iowa State University's Research Centers in Ames and Kanawha to evaluate the effectiveness of anions, a cation, and a fluorescent dye as tracers for investigating how agricultural chemicals leach to groundwater.In one tracer experiment, bromide, nitrate, lithium, and Rhodamine WT were applied with irrigation water to the field plot through a sprinkler system. In the second study, bromide, chloride, and Rhodamine WT were mixed with two herbicides (cyanazine and alachlor) and were sprayed on the surface of the plot, which received rainfall with a rainfall simulator. During and after the experiments, groundwater samples were collected from subsurface drain outflows (located at a depth of 1.2 m). These samples were analyzed for tracer and chemical concentrations. Based on adsorption coefficients in the literature and field experiments, Rhodamine WT dye is roughly 20 to 40 times more strongly adsorbed than the commonly used pesticides. Experimental results also indicate that a combination of adsorbed tracers (fluorescent dyes) and non-adsorbed tracers (anions) have the potential for tracing the movement of water as well as adsorbed and non-adsorbed chemicals (nitrates and pesticides). (See also W91-05611) (Author's abstract)
W91-05660

UTILIZATION OF INTRACELLULAR GRANULES OF INT-FORMAZAN AND GENE PROBES FOR TRACING MICROORGANISMS IN GROUND WATER.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
A. J. Alvarez, S. I. Davila, and G. A. Toranzos.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, PR., July 22-27, 1990. American Water Resources Association, Bethesda, MD. (1990). p 495-503, 7 fig, 20 ref. INDUNIV Grant 9020539303, R.I.M.I. Grant

M3289B91, and Public Health Service Grants RR-2657 and RR-8102.

Descriptors: *Biological pollution, *Environmental tracers, *Formazan, *Genes, *Groundwater pollution, *Intracellular granules, *Path of pollutants, *Tracers, *Tropical hydrology, Bacteria, Laboratory methods, Microbiological studies, Organic compounds, Tetrazolium chloride.

Currently used methods (halogen salts or fluorescein dyes) for tracing microorganisms in groundwater aside from being toxic do not necessarily reflect bacterial movement. Living cells reduce 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium chloride to 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium chloride-Formazan, which accumulates as intercellular granules. The granules can be used as markers for genetically engineered organisms as well as for pathogenic microorganisms. The use of genetic probes has been shown to be a sensitive technique, although cumbersome for the detection of organisms under a variety of conditions. In this study, a strain of formaldehyde fixed 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium chloride-formazan granule containing genetically engineered microorganisms was seeded into sand columns. The adsorption rate and genetically engineered organisms travel time were determined at varying times by concentrating granule-containing cells onto cellulose acetate membranes, and passing 4 ml of a solvent through the membranes. The resulting extract was read spectrophotometrically. Radioactively labeled probes were also used to detect these very same cells. In the sand columns viable cells move at the same rate as the non-viable cells. Travel times of two genetically engineered microorganisms were different. These results indicate that the adsorption rates as well as possible travel distances in the subsoil will have to be determined for each individual organism. In addition results show that granule solubilization and hybridization analysis can be used alone or conjointly to trace any microorganisms through the subsoil in a very rapid and safe manner. (See also W91-05611) (Author's abstract)
W91-05661

OPTIMAL CONFIGURATION AND SCHEDULING OF GROUND-WATER TRACER TEST.
California Univ., Los Angeles. Dept. of Civil Engineering.
T. G. Cleveland, and W. W.-G. Yeh.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 37-51, 1991. 9 fig, 4 tab, 20 ref. Department of Interior, U.S. Geological Survey grant 14-08-0001-G1499.

Descriptors: *Dynamic programming, *Groundwater pollution, *Model studies, *Network design, *Path of pollutants, *Tracers, Algorithms, Budgeting, Finite difference methods, Model testing, Monitoring, Optimization, Scheduling, Water sampling.

A technique for jointly configuring and scheduling a monitoring network for an aquifer tracer test has been developed. A dynamic programming (DP) algorithm is used to select among competing designs for a test to provide data for estimating aquifer model parameters. A maximal information criterion is used to evaluate competing designs that satisfy a particular budget constraint. Decision variables in DP formulation are sampling locations (configuration variables) and sampling initiation times (scheduling variables). A forward DP solution method is used, optimal configuration and scheduling are determined by maximizing information without exceeding a budget. Maximization of information is argued to be equivalent to minimizing total cost of installation as well as sampling and analysis subject to an information demand function constructed from the trace of the covariance matrix of the estimated parameters. A tracer test for a confined aquifer was simulated using a finite difference scheme. A short injection period followed by a monitoring period was simulated. The DP algorithm was applied to this model to design a monitoring network and schedule to estimate aquifer characteristics. The sampling network and schedule was designed with estimation of transmissivity, retardation, and dispersivities in mind. Resulting designs were reasonable, and it may be concluded that the method can be extended to regional-sized problems with little modification. (Author's abstract)
W91-05789

MULTIPHASE FLOW AND TRANSPORT IN POROUS MEDIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. C. Parker.
Reviews of Geophysics RVGPB4, Vol. 27, No. 3, p 311-328, August 1989. 15 fig, 1 tab, 30 ref. U.S. Environmental Protection Agency R. S. Kerr Environmental Research Laboratory cooperative agreement CR-812073.

Descriptors: *Groundwater pollution, *Hydrodynamics, *Multiphase flow, *Path of pollutants, *Porous media, *Solute transport, Compressibility, Continuity equation, Darcys law, Density, Groundwater movement, Hydrologic models, Hysteresis, Numerical analysis, Permeability, Porosity, Soil saturation, Viscosity coefficient.

Multiphase flow and transport of compositionally-complex fluids in geologic media is of importance in a number of applied problems which have major social and economic effects. Principles of modeling fluid flow in systems containing up to three fluid phases (namely, water, air, and organic liquid) were examined. Mechanisms of transport in multicomponent multiphase systems in which species may partition between phases was examined, and the governing equations were developed for the case in which local phase equilibrium may be assumed. A generalized Darcy equation was substituted into continuity equations. Coefficients required to model multiphase flow include phase viscosities; reference state densities and compressibilities; porous medium porosity; intrinsic permeability or saturated conductivity of a single phase; and functional relations between fluid saturations, pressure heads, and relative permeabilities. Constitutive relations for multiphase flow must be characterized, such as two-phase and three-phase saturation-capillary pressure relations, vertical equilibrium fluid distributions, and relative permeability relations. The behavior of components of the organic liquid phase is important to the study of groundwater contamination because of the finite solubility in the aqueous phase and volatility to the gas phase. A number of hypothetical numerical problems were used to illustrate the physical behavior of systems in which multiphase flow and transport arise, including oil plume movement under rising water table conditions, density and viscosity effects on spill migration, and coupled flow and transport of a light hydrocarbon plume. Models to account for hysteresis and nonwetting fluid entrapment effects, in particular, remain quite speculative. (Fish-PTT)
W91-05798

MAPPING ZONES OF CONTAMINATED GROUND-WATER DISCHARGE USING CREEK-BOTTOM-SEDIMENT VAPOR SAMPLERS, ABERDEEN PROVING GROUND, MARYLAND.
Geological Survey, Columbia, SC.
D. A. Vroblesky, M. A. Lorah, and S. P. Trimble.
Ground Water GRWAAP, Vol. 29, No. 1, p 7-12, January/February 1991. 6 fig, 1 tab, 8 ref.

Descriptors: *Groundwater pollution, *Mapping, *Path of pollutants, *Surface-groundwater relations, *Volatile organic compounds, Aberdeen Proving Ground, Chlorinated hydrocarbons, Groundwater movement, Maryland, Military reservations, Monitoring wells, Sampling.

Increased understanding of discharge-zone geometry provides information on the lateral extent of groundwater contamination near the discharge zone and may lead to more efficient site remediation. The data potentially can be used to locate observation well sites more effectively and monitor remediation progress. Forty passive vapor samplers were placed in creek-bottom sediment in an area where groundwater contaminated with volatile organic compounds discharged to surface water. The vapor samplers were composed of activated carbon fused to a ferromagnetic wire in a test tube. The samplers were analyzed in a laboratory using an extranuclear quadrupole mass spectrometer. Data from the samplers reveal distributions of chloroform, tetrachloroethylene, trichloroethylene, and benzene in the bottom sediment that closely correspond to the distribution of those compounds in the adjacent groundwater. Moreover, concentrations of tetrachloroethylene in bottom sediment estimated from the samplers are similar to those measured in observation wells near the shoreline. Thus, the passive vapor samplers may be used to locate and map areas where contaminated groundwater is being discharged to surface water and to determine the approximate concentrations of specific contaminants in the discharging groundwater. (Author's abstract)
W91-05813

MODELING SOLUTE TRANSPORT IN GROUND WATER AT OR NEAR FREEZING.
Alaska Univ., Fairbanks. Dept. of Mining and Geological Engineering.
M. D. Zukowski, and M. A. Tumeo.
Ground Water GRWAAP, Vol. 29, No. 1, p 21-25, January/February 1991. 6 fig, 18 ref.

Descriptors: *Cold regions, *Freezing, *Groundwater movement, *Model studies, *Path of pollutants, *Solute transport, Alaska, GWFREEZE model, Hydrologic models, Mathematical models, Prediction, Temperature, Viscosity.

Under freezing or near-freezing conditions, temperature-induced viscosity changes, solute immobilization, and solute exclusion can affect field-scale solute transport in groundwater. This can lead to concentration profiles significantly different from those predicted by models that do not account for these processes. A model (GWFREEZE) has been developed that incorporates these processes into a two-dimensional transport equation for saturated porous media subject to a hydraulic head that does not vary with time. Groundwater temperature can be expected to vary widely in some natural and artificial freezing and near-freezing situations. Spatially varying temperature fields cause spatial variations in the fluid viscosity field, especially near 0 C, where viscosity varies faster than temperature. GWFREEZE models these phenomena with a viscosity-dependent hydraulic conductivity that is a function of temperature. Solute exclusion is modeled by a variable exclusion coefficient, which represents the percentage of solute excluded at the freezing front. The freezing front is modeled as a planar no-flow boundary behind which solutes are immobilized and at which solutes are excluded. (Author's abstract)
W91-05816

'WHERE'S THE BENZENE': EXAMINING CALIFORNIA GROUND-WATER QUALITY SURVEYS.
Applied Science and Engineering, Inc., Davis, CA.
P. W. Hadley, and R. Armstrong.
Ground Water GRWAAP, Vol. 29, No. 1, p 35-40, January/February 1991. 5 tab, 29 ref.

Descriptors: *Benzene, *California, *Fate of pollutants, *Groundwater pollution, *Pollutant identification, *Underground storage tanks, Biodegradation, Fuel, Leakage, Monitoring wells, State jurisdiction, Surveys.

Thousands of leaking underground gasoline tanks have been located throughout California from which a tremendous amount of gasoline has leaked into groundwater over the last half century. The most water-soluble constituent of gasoline is benzene, which typically contaminates groundwater below leaking underground tanks. In a state-mandated program, 7167 wells serving water-supply systems throughout California were tested for a broad panel of organic contaminants. Of the wells tested 812 (11.3%) had detectable concentrations of at least one of the contaminants tested for. Detectable concentrations of benzene were report-

ed for only 10 wells. Similar findings were reported in surveys focused on the San Gabriel and San Fernando Basins. While many processes influence the environmental fate of organic contaminants in groundwater, the most likely explanation for the nonoccurrence of benzene is that it is destroyed near its source by biodegradation. (Author's abstract)
W91-05818

SIMPLE DERIVATION OF THE RETARDATION EQUATION AND APPLICATION TO PREFERENTIAL FLOW AND MACRODISPERSION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2F.
W91-05819

ASSESSMENT OF POROUS MEDIA HETEROGENEITY BY INVERSE PLUME ANALYSIS.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
E. P. Poeter, and W. R. Belcher.
Ground Water GRWAAP, Vol. 29, No. 1, p 56-62, January/February 1991. 10 fig, 1 tab, 12 ref. Batelle Pacific Northwest Laboratory Agreement B-N9191-A-6 (USDOE Contract DE-AC06-76RLO 1830) and USDOE Contract DE-AM06-76-RL02225.

Descriptors: *Dispersion, *Groundwater pollution, *Mathematical analysis, *Model studies, *Path of pollutants, *Plumes, Dispersivity, Heterogeneity, Porous media, Spatial variation.

Results from analysis of models of heterogeneous porous media indicate that inverse plume analysis has potential for use in delineating zones of differing characteristics within porous media even when the zones are not penetrated by a borehole. By analyzing the concentrations at pairs of points in a contaminant plume, the spatial distributions of apparent transverse dispersivity and source size are determined. Since dispersivity is an intrinsic property of a porous medium, spatial distributions of the apparent dispersivities obtained from inverse analysis of plumes are an indication of transitions in the character of the porous medium. Dispersivity values obtained by inverse plume analysis in heterogeneous porous media are 'apparent' because the equation on which the analysis was based was developed under the assumption that the porous media is isotropic and homogeneous. In the case of heterogeneous porous media, the dispersivity value obtained at a given location by inverse plume analysis is affected by the spreading of a plume through different materials. Therefore, variations in dispersivity should be interpreted qualitatively for delineation of heterogeneity and not quantitatively as for input to numerical transport models. (Author's abstract)
W91-05821

PARTICLE TRACKING ANALYSIS OF RECHARGE AREAS ON LONG ISLAND, NEW YORK.
Geological Survey, Trenton, NJ.
H. T. Buxton, T. E. Reilly, D. W. Pollock, and D. A. Smolensky.
Ground Water GRWAAP, Vol. 29, No. 1, p 63-71, January/February 1991. 10 fig, 3 tab, 7 ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Groundwater recharge, *Long Island, *New York, *Path of pollutants, *Tracers, *Water pollution sources, Aquifers, Hydrologic budget, Hydrologic models, Lloyd Aquifer, Magothy Aquifer, Particle tracking, Prediction, Spatial distribution.

Protection of groundwater resources form the effects of anthropogenic contamination requires definition of the source of water flowing in developed aquifers. Aquifer recharge areas for the confined Magothy and Lloyd aquifers of Long Island, New York, were estimated using a three-dimensional model of the Long Island groundwater flow system and a particle-tracking algorithm. Aquifer recharge areas under predevelopment conditions are consistent with an understanding of the groundwater flow system operation. A budget comparison indicated that the recharge occurring in each area as calculated by particle tracking was within 1% of the flow entering the aquifer according to the water budget computed from the flow model. Aquifer recharge areas of two stressed conditions, one at the present time and the other an estimate for the year 2020, are more difficult to define because of numerous pumped wells. Maximum and minimum recharge areas for each aquifer were calculated for both present conditions and for the year 2020 to bracket the actual aquifer recharge areas. These results also are consistent with the water budgets computed from the flow model. Results indicate that development causes large-scale changes in flow patterns and the size and shape of aquifer recharge areas. The accuracy of defining recharge areas is limited by the model's representation of local-scale characteristics of the flow system and the wells. (Author's abstract)
W91-05822

GROUND-WATER CONTAMINATION FROM TWO SMALL SEPTIC SYSTEMS ON SAND AQUIFERS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
W. D. Robertson, J. A. Cherry, and E. A. Sudicky.
Ground Water GRWAAP, Vol. 29, No. 1, p 82-92, January/February 1991. 10 fig, 3 tab, 32 ref.

Descriptors: *Groundwater pollution, *Ontario, *Plumes, *Sand aquifers, *Septic tanks, *Wastewater pollution, *Water pollution sources, Alkalinity, Dissolved organic carbon, Dissolved oxygen, Groundwater movement, Hydrogen ion concentration, Ions, Nitrates, Regulations, Sodium, Unconfined aquifers.

Distinct plumes of septic-impacted groundwater at two single-family homes located on shallow unconfined sand aquifers in Ontario (Canada) showed elevated levels of chloride, nitrate, sodium, calcium, potassium, alkalinity, and dissolved organic carbon and depressed levels of pH and dissolved oxygen. At the Cambridge site, in use 12 yr, the plume had sharp lateral and vertical boundaries and was more than 130 m in length with a uniform width of about 10 m. As a result of low transverse dispersion in the aquifer, mobile plume solutes such as nitrate and sodium ion occurred at more than 50% of the source concentrations 130 m downgradient from the septic system. At the Muskoka site, in use 3 yr, the plume also had discrete boundaries reflecting low transverse dispersion. After 1.5 yr of system operation, the Muskoka plume began discharging into a river located 20 m from the tile field. Almost complete nitrate attenuation was observed within the last 2 m of the plume flowpath before discharge to the river. This was attributed to denitrification occurring within organic matter-enriched riverbed sediments. The very weakly dispersive nature of the two aquifers was consistent with the results of recently reported natural-gradient tracer tests in sands. Therefore, for many unconfined sand aquifers, the minimum distance-to-well regulations for permitting septic systems in most parts of North America should not be expected to be adequately protective of well-water quality in situations where mobile contaminants such as nitrate are not attenuated by chemical or microbiological processes. (Author's abstract)
W91-05824

EMPIRICAL BAYES REGIONALIZATION METHODS FOR SPATIAL STOCHASTIC PROCESSES.
Gradient Corp., Cambridge, MA.
For primary bibliographic entry see Field 2F.
W91-05832

LABORATORY ANALYSIS OF FLUID FLOW AND SOLUTE TRANSPORT THROUGH A FRACTURE EMBEDDED IN POROUS TUFF.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W91-05836

STEADY FLUID FLOW AND TRAVEL TIMES IN PARTIALLY SATURATED FRACTURES USING A DISCRETE AIR-WATER INTERFACE.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W91-05837

GROUNDWATER CONTAMINATION STUDIES--THE STATE-OF-THE-ART.
University of Petroleum and Minerals, Dhahran (Saudi Arabia).
A. N. Khondaker, R. I. Al-Layla, and T. Husain.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 20, No. 4, p 231-256, 1990. 1 fig, 1 tab, 319 ref, append.

Descriptors: *Groundwater pollution, *Interdisciplinary studies, *Literature review, *Research priorities, *Solute transport, Fate of pollutants, Geochemistry, Geohydrology, Geology, Geophysics, Groundwater movement, Hydrologic models, Mathematical studies, Model studies, Path of pollutants, Physical models.

With the increasing sense of awareness and the recognition of the need for environmental protection, the study of solute transport related to groundwater contamination has become the focus of numerous researchers. The problem has been approached from many viewpoints, and the resulting achievements are so extensive and scattered that it seems essential to inventory the completed works. A systematic study was made of the available theoretical and experimental works. The study of groundwater flow and contaminant transport requires knowledge of many of the basic principles of geology, physics, chemistry, and mathematics; there is a close kinship between groundwater hydrology, soil physics, soil mechanics, rock mechanics, and petroleum engineering. These interdisciplinary studies can be broadly categorized as theory and development of solute-transport phenomena, modeling of solute transport, and studies on model parameters. There are a number of important areas which need further research to predict the fate and the behavior of contaminants in the subsurface system, including: (1) additional work to derive field-scale models; (2) correlation between field and laboratory values of input parameters for solute transport models; (3) continued investigation of the geochemistry of contaminant reactions in both saturated and unsaturated subsurface environments; (4) further study of the chemical and biological reaction on the permeability of aquifer materials; (5) systematic comparison of all existing models and the advanced solution techniques; (6) development of an efficient model including all the biological processes; (7) better understanding of reaction rates in the subsurface environment. The necessity of interdisciplinary cooperation among investigators is essential for the future advancements in the ability to deal with groundwater contamination problems. (Fish-PTT)
W91-05848

CHEMICAL ANALYSIS OF RAIN SAMPLES COLLECTED OVER THE PACIFIC OCEAN.
National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs.
For primary bibliographic entry see Field 2K.
W91-05862

BERYLLIUM-7 AND LEAD-210 IN THE ATMOSPHERE AND SURFACE SNOW OVER THE GREENLAND ICE SHEET IN THE SUMMER OF 1989.
New Hampshire Univ., Durham. Inst. for the Study of Earth, Oceans and Space.
For primary bibliographic entry see Field 2K.
W91-05864

METHANE FLUXES IN WETLAND AND FOREST SOILS, BEAVER PONDS, AND LOW-ORDER STREAMS OF A TEMPERATE FOREST ECOSYSTEM.
Cornell Univ., Ithaca, NY. Dept. of Natural Re-

sources.
J. B. Yavitt, G. E. Lang, and A. J. Sexstone.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 13, p 22,463-22,474, December 20, 1990. 6 fig, 3 tab, 46 ref. NASA grant NAGW-842; NSF grant BSR 85-16700; EPA cooperative agreement CR81265 with Cornell University.

Descriptors: *Air pollution sources, *Forest watersheds, *Methane, *Paths of pollutants, *Wetlands, Air-earth interfaces, Air-water interfaces, Ecosystems, Forest soils, Global warming, Greenhouse effect, Maryland, Temperate zone, Tropical regions, West Virginia.

Studies in tropical and boreal regions suggest that wetlands and forest soils are important sources and sinks for atmospheric methane. A study was conducted to determine whether temperate wetlands and forests play important roles in the global balances of atmospheric methane. Flux measurements for methane in several different wetland, forest, and open-water (e.g., beaver pond and low-order stream) sites were determined using collection chambers placed over the soil-air or water-air interface. All of the sites were located in the Appalachian Mountain region of West Virginia and western Maryland. Between June 1987 and April 1989 the wetland sites acted as small sources of atmospheric methane, with emission rates for methane usually <200 mg CH4/sq-m/d; consumption of atmospheric methane in the wetland soils was observed frequently. The forest sites were mostly atmospheric methane sinks, even though emission rates (<40 mg CH4/sq-m/d) were observed sporadically. Open-water sites were large sources of atmospheric methane, with emission rates often exceeding 1000 mg CH4/sq-m/d. Methane fluxes were poorly correlated with environmental variables including soil moisture, soil and air temperature, and cloud cover, thereby making it difficult to determine the factors controlling methane fluxes in these sites. Scenarios of future global climate warming due to an increasing greenhouse effect suggest that wetlands and forests in the southern boreal forest will begin to resemble present-day temperate wetlands and forests. The results of these studies suggest that methane emissions from these 'temperatelike' ecosystems will not result in a large positive feedback that might exacerbate the rate of global climate warming. (Author's abstract)
W91-05865

PREFERENTIAL FLOW IN A SANDY VADOSE ZONE: 2. MECHANISM AND IMPLICATIONS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05877

STUDIES OF CADMIUM UPTAKE IN BONE AND ITS ENVIRONMENTAL DISTRIBUTION.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
S. S. Krishnan, S. M. W. Lui, R. E. Lewis, and J. E. Harrison.
Biological Trace Element Research BTERDG, Vol. 26/2, p 257-261, July/December 1990, 3 tab, 4 ref.

Descriptors: *Adsorption, *Bioaccumulation, *Cadmium, *Heavy metals, *Path of pollutants, *Toxicity, *Trace elements, Animal pathology, Atomic absorption spectrophotometry, Canada, Distribution patterns, Fertilizers, Foods, Histology, Neutron activation analysis, Rats, Sludge.

Rat experiments indicate that oral ingestion of cadmium through drinking water leads to an accumulation of cadmium in bone, in addition to liver and kidney. After five weeks of cadmium intake in drinking water (50 to 100 mg/L), the bone cadmium levels increased in proportion to the intake concentration. Bone and kidney histology showed no signs of damage up 5 wk of cadmium ingestion. Cadmium accumulation in bone was a primary phenomenon and not secondary to renal failure. In addition, cadmium levels have been estimated in a variety of sources, e.g., foodstuff, fertilizer, and sewage sludge, using neutron and proton activation analyses and atomic absorption spectrophotometry. Cadmium levels of Canadian foods are in the range of 0.002-0./07 mg/kg, and soils are in the range of 0.55 to 1.72 mg/kg. Fertilizers contain cadmium from 0.3 to 1.25 mg/kg, whereas sewage sludge contains up to 122 mg/kg. (Author's abstract)
W91-05895

ENVIRONMENTAL IMPACT OF GOLD MINING INDUSTRY IN GHANA.
Ghana Univ., Legon. Dept. of Physics.
For primary bibliographic entry see Field 4C.
W91-05896

ENVIRONMENTAL RESEARCH ON TRACE ELEMENTS IN FRESHWATER FISH BY NEUTRON ACTIVATION ANALYSIS.
Korean Inst. of Energy and Resources, Seoul (Republic of Korea).
K. S. Park, N. B. Kim, H. J. Woo, Y. Y. Yoon, and K. Y. Lee.
Biological Trace Element Research BTERDG, Vol. 26/2, p 347-354, July/December 1990, 2 fig, 3 tab, 13 ref.

Descriptors: *Fish populations, *Korea, *Neutron activation analysis, *Path of pollutants, *Stream pollution, *Trace elements, Cadmium, Han River, Mercury, Radiochemical analysis, Tissue analysis, Water quality trends.

In a case study of environmental contamination, radiochemical activation analysis was applied to freshwater fishes (of the crucian group) collected in the Han River in Korea. Sixteen trace elements (Hg, Cd, As, Br, Cu, Na, K, Se, Cr, Hf, Rb, Fe, Zn, Co, La, and Cs) were separated into three groups using distillation and diethyldithiocarbamate extraction methods, and their concentrations were determined by a single comparator method. Compared with values 15 years ago, the values for mercury and cadmium have drastically decreased in the middle and lower part of the river. The reason seems to be that several sewage treatment facilities were installed, and contaminated sediment has been cleaned up during the Han River redevelopment project. With the exception of selenium, concentrations of all other elements increase slightly in the down stream direction; the significance of this trend is not yet known. Selenium concentrations, in contrast, decrease in the downstream direction; the reason for this is also unknown. (Doyle-PTT)
W91-05897

IDENTIFYING SOURCES OF GROUNDWATER POLLUTION USING TRACE ELEMENT SIGNATURES.
Massachusetts Inst. of Tech., Cambridge. Nuclear Reactor Lab.
I. Olmez, and M. J. Hayes.
Biological Trace Element Research BTERDG, Vol. 26/2, p 355-361, July/December 1990, 2 fig, 1 tab, 8 ref.

Descriptors: *Environmental tracers, *Groundwater pollution, *Neutron activation analysis, *Path of pollutants, *Trace elements, *Water pollution sources, Distribution patterns, Hazardous wastes, Land disposal, Model studies, Powerplants, Test wells.

A simple receptor modeling approach has been applied to groundwater pollution studies and has shown that marker trace elements can be used effectively in source identification and apportionment. This new approach to groundwater studies is successful because, unlike organic compounds, inorganic elements carry exactly the same signatures as the source material regardless of the distance between the source and the monitoring wells. For example, vanadium and rare earth elements are indicators of oil combustion; Pb in urban areas originates from motor vehicles; S, Se, and As are almost always associated with coal related pollution. Groundwater and source materials from one coal-fired and five oil-fired power plants, and one coal-tar disposal site have been analyzed by instrumental neutron activation analysis for more than 20 minor and trace elements. In one of the oil-fired power plants, trace element patterns indicated a leak from the hazardous waste surface impoundments owing to the failure of the hypolon liner. Also, the extent and spatial distribution of groundwater contamination have been determined in a coal-tar disposal site. (Doyle-PTT)
W91-05898

HISTORY OF A CHLORPYRIFOS SPILL: CARTAGENA, COLOMBIA.
Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.
U. M. Cowgill, R. T. Gowland, C. A. Ramirez, and V. Fernandez.
Environmental International ENVIDV, Vol. 17, No. 1, p 61-71, 1991, 1 fig, 6 tab, 9 ref.

Descriptors: *Chlorpyrifos, *Colombia, *Fate of pollutants, *Marine pollution, *Organophosphorus pesticides, *Spills, Bays, Cartagena, Cleanup operations, Fishkill, Rehabilitation, Water pollution effects.

Due to an operational error, a small amount of chlorpyrifos (an organophosphorus compound) entered the bay of Cartagena, Colombia. The resulting fish kill was extensive (17 tons). To hasten the degradation process, the contaminated sediment, the main source of chlorpyrfos to the bay, was repeatedly removed. In addition, the exact amount spilled is unknown. Thus, rates of disappearance can only be estimated. Under the physical conditions of the Bay of Cartagena, the half-life in water is about 9 days and in fish 11 days. The Bay showed considerable recovery from the biological and chemical effects of the chlorpyrfos spill in 23 days, i.e., chlorpyrifos was below the limits of detection (at or <0.3 microgram/L) in water. During days 3-6 of this study, residue levels in live fish caught were below the level that would cause a human health problem if they were eaten. (Author's abstract)
W91-05901

STUDY OF CARBOFURAN MOVEMENT IN SOILS: PART I--SOIL STRUCTURE.
Laboratoire de Protection des Cultures, Nancy (France).
J. Achik, M. Schiavon, and P. Jamet.
Environmental International ENVIDV, Vol. 17, No. 1, p 73-79, 1991, 7 fig, 2 tab, 13 ref.

Descriptors: *Adsorption, *Carbamate pesticides, *Carbofuran, *Desorption, *Path of pollutants, *Pesticides, *Soil contamination, Clay loam, Clay soils, Isotherms, Leaching, Percolation tests.

Under natural conditions, drained water of a clay soil rich in organic matter was shown to be systematically more highly contaminated than that of a loamy clay soil. To study this phenomenon, laboratory soil columns were used to determine the role of soil structure, percolation speed, and product dose on carbofurans movement and leaching. Although these factors modify insecticide transfer, it was observed that the soil theoretically having the stronger adsorption capacity did not retain the product well. Hence, a comparative study of the adsorption-desorption phenomena was conducted. Analysis of experimental data for adsorption and desorption isotherms showed that organic clay is indeed the most adsorbing system and the most suitable for retaining the product. Modification of certain experimental parameters, such as the aggregate size or the percolation speed, showed that carbofuran movement can be significantly modified and the adsorbing power of the soil supressed. (See also W91-05903) (Doyle-PTT)
W91-05902

STUDY OF CARBOFURAN MOVEMENT IN SOILS: PART II-KINETICS.
Laboratoire de Protection des Cultures, Nancy (France).
J. Achik, M. Schiavon, and P. Jamet.
Environmental International ENVIDV, Vol. 17, No. 1, p 81-88, 1991, 7 fig, 4 tab, 6 ref.

Descriptors: *Adsorption kinetics, *Carbamate pesticides, *Carbofuran, *Mathematical models, *Path of pollutants, *Pesticide kinetics, *Soil contamination, Adsorption, Carbon radioisotopes, Clay loam, Clay soils, Desorption, Radioactivity techniques.

The time variation of the quantity of Carbon-14 carbofuran adsorbed on two agricultural soils was evaluated by an agitation-type technique. The experimental results showed the occurrence of a 'rapid' adsorption phase, followed by a 'slow' adsorption phase. Three mathematical models describing the adsorption or adsorption-desorption kinetics of pesticides in soil were used and discussed for analyzing and comparing the behavior of the carbofuran in two soils. These models included a hyperbolic model and two 2 or 3 compartment models. The three compartment model yielded the highest estimated values for the maximum amount of adsorbed carbofuran. The clay soil had greater adsorptive capacity than the loamy clay soil. The results indicate that carbofuran tended to desorb (the desorption rate constant was greater than the adsorption rate constant) and explain, at least partially, the mobility of carbofuran specific to certain soils. (See also W91-05902) (Author's abstract)
W91-05903

QUESTION OF NITRATES.
Salford Univ. (England). Environmental Resources Unit.
M. J. Muia, and M. P. Thomas.
Environmental Education & Information EEDIEF, Vol. 9, No. 2, p 91-100, 1991, 20 ref.

Descriptors: *Fertilizers, *Groundwater pollution, *Human diseases, *Nitrates, *Nitrogen removal, *Water pollution control, *Water pollution effects, *Water pollution sources, Agricultural practices, Algal blooms, Cancer, England, European Economic Community, Eutrophication, Waste disposal, Water treatment.

Nitrogen, when present in large amounts in the diet is believed to cause methaemoglobinaemia (cyanosis) in infants, and, gastric cancers resulting from its conversion to nitrosamines in the stomach. In addition, it is responsible for algal blooms which starve other organisms of oxygen. Changes in agricultural practices are needed to reduce the risk of groundwater pollution by nitrates from nitrogen fertilizers, since about 20% of the nitrates in our diets come from water, while 80% comes from foods. Other sources of nitrates such as cattle slurry, sewage sludge and effluent should be released to the environment under careful control to avoid exceeding European Community maximum admissible nitrate limits of 50 mg/L in drinking water. Such measures include limiting the amount of fertilizer applied in the autumn since it is poorly adsorbed in the winter and more readily leached, and inhibiting nitrification by using a material like dicyandiamide to improve nitrogen utilization. Several methods of reducing nitrates in water include blending and long term storage, use of ion exchange resins, and biological fluidised beds. Although the incidents of gastric cancer and cyanosis are low in Britain, nitrate levels should be maintained at low level until research proves conclusively that nitrates in drinking water are not responsible for these conditions. (Doyle-PTT)
W91-05904

METAL POLLUTION IN SEDIMENTS OF JAMAICA BAY, NEW YORK, USA-AN URBAN ESTUARY.
Yale Univ., New Haven, CT. Dept. of Geology and Geophysics.
D. E. Seidemann.
Environmental Management EMNGDC, Vol. 15, No. 1, p 73-81, January/February 1991, 3 fig, 5 tab, 23 ref.

Descriptors: *Estuarine sediments, *Heavy metals, *Jamaica Bay, *Sediment contamination, *Urban areas, Atmospheric deposition, Landfills, Leachates, New York, Organic carbon, Wastewater pollution.

Calculations of the annual input of heavy metals to Jamaica Bay, New York, reveal that sewage effluent carries the largest quantities of Ni, Zn, Cu, and Cd to the bay. Storm sewers and atmospheric fallout are the main sources of Pb. Atmospheric fallout of Zn, Cu, and Cd, although smaller than the combined input from sewers contributes a significant fraction of these metals. The metal input from landfill leachate is far smaller than from other sources. Analysis of available data shows that metal concentrations in the sediment of the bay correlate with each other and with percent total organic carbon (%TOC). This is consistent with the observation that the input of metals is predominantly associated with sewage. It is demonstrated that metal-TOC ratios, rather than metal concentrations, must be used in efforts to detect local intensive sources of metals in solution; metal-TOC ratios in intertidal sediment adjacent to these landfills are elevated by the adsorption of leachate metals, while metal concentrations are not. Subtidal sediment within a few hundred meters from two landfills shows no evidence of addition of metals from that source, which is consistent with the small input of metals estimated for these landfills. The evidence cited in this study sharply contradicts the implication made in a widely publicized report issued by an environmental advocacy group that a significant link exists between metals found in subtidal sediment of Jamaica Bay and landfill leachate. (Author's abstract)
W91-05906

RECOGNITION OF AREAS EFFECTED BY PETROLEUM SEEPAGE: NORTHERN GULF OF MEXICO CONTINENTAL SLOPE.
Texas A and M Univ., College Station. Geochemical and Environmental Research Group.
M. C. Kennicutt, and J. M. Brooks.
Geo-Marine Letters GMLEDI, Vol. 10, No. 4, p 221-224, 1990, 2 fig, 22 ref.

Descriptors: *Gulf of Mexico, *Hydrocarbons, *Marine pollution, *Oil, *Seeps, *Water pollution sources, Benthic environment, Continental slope, Geologic formations, Marine sediments, Ocean bottom, Tectonics.

The presence of large amounts of gas and/or liquid hydrocarbon seepage in near-surface sediments can produce distinct features including irregular topography (on several scales, ranging from meters to kilometers); seismically transparent/chaotic sediments; oil staining; gas plumes; sediments containing elevated concentrations of extractable organic matter organic carbon, and calcium carbonate; associated brine seepage and anoxic conditions; extensive bacterial mats; hydrate formation and decomposition; and dense chemoautotrophic communities. Although no single characteristic is always uniquely associated with seepage, the co-occurrence of several of these features is strongly suggestive of an area being exposed to non-indigenous upward migrating hydrocarbons. Chaotic facies which can result from the presence of secondary carbonate or sulfides that commonly co-occur with seepage have been documented over a large area of the Gulf of Mexico where a majority of locations exhibiting seismically-transparent sediments contain carbonate accumulations, gas pockets and/or hydrates. Salt diapirism has been shown to be especially important in controlling the distribution of petroleum seepage on the northern Gulf of Mexico continental shelf/slope. The occurrence of deeper-seated hydrocarbons (source rocks and/or reservoired oil/gas) and salt-induced faulting, that provides conduits for migration, intimately links seepage and salt tectonics on this slope. At Green Canyon Lease Block 184/185 on the Louisiana continental slope, oil and gas in shallow sediments are similar to oil and gas reservoired 2000 to 3000 m deep in the subsurface. (Doyle-PTT)
W91-05915

SEA FLOOR RESPONSES TO HYDROCARBON SEEPS, LOUISIANA CONTINENTAL SLOPE.
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.
H. H. Roberts, P. Aharon, R. Carney, J. Larkin, and R. Sassen.
Geo-Marine Letters GMLEDI, Vol. 10, No. 4, p 232-243, 1990, 9 fig, 21 ref. NOAA Grants NA80AA-8-00081 and NA88AA-D-UR004 and Louisiana State University Center for Energy Studies grant 135-15-0150.

Descriptors: *Continental slope, *Hydrocarbons, *Louisiana, *Marine pollution, *Ocean bottom, *Petroleum hydrocarbons, *Seeps, *Water pollution sources, Benthos, Calcium carbonate, Geologic formations, Gulf of Mexico.

Observations and samples from research submersible dives confirm that brines, crude oil, fluid mud, and gases are common seep products. Through this mechanism a unique interplay of geochemical, geologic, and biological processes resulting in unusual sea floor features ranging from carbonate rich nodular sediments to mounds with tens of meters of relief. Stable carbon isotopes occluded in the carbonates provide a permanent imprint that links these authigenic carbonates to by-products of microbial breakdown of crude oil and gas. Recent DSV ALVIN dives confirm that hydrocarbon seeps on the Louisiana continental slope are numerous and display a high degree of variability with regard to seafloor response features. Seeps and their accompanying chemosynthetic communities and authigenic carbonate mounds occur over the entire depth range of the slope. Mound morphologies, internal components, and geochemical characteristics of the carbonates suggest both seafloor and shallow subsurface origins. (Doyle-PTT)
W91-05916

GULF OF MEXICO HYDROCARBON SEEP COMMUNITIES: VI. PATTERNS IN COMMUNITY STRUCTURE AND HABITAT.
Texas A and M Univ., College Station. Geochemical and Environmental Research Group.
I. R. MacDonald, N. L. Guinasso, J. F. Reilly, J. M. Brooks, and W. R. Callender.
Geo-Marine Letters GMLEDI, Vol. 10, No. 4, p 244-252, 1990, 6 fig, 39 ref.

Descriptors: *Benthic environment, *Benthic fauna, *Ecosystems, *Gulf of Mexico, *Hydrocarbons, *Seeps, *Water pollution sources, Coastal environment, Continental shelf, Ocean bottom, Oil, Species composition, Sulfur cycle.

Communities of chemosynthetic fauna that depend on seeping oil and gas have been found in the Gulf of Mexico at approximately 45 sites between 88 degrees W and 95 degrees W and between the 350 and 2,200 m isobaths. Since the initial discovery of hydrothermal venting in 1977, occasioned in part by the observation of anomalous concentrations of clams in an otherwise depauperate abyssal zone, investigations suggest that the number of sites and range of occurrence will increase with additional exploration. The dominant fauna consist of species within four groups: tube worms, seep mussels, epibenthic clams, and infaunal clams. These species co-occur to some degree, but tend to form assemblages dominated by a single group. Community development is closely coupled to geological and geochemical processes of seepage. At hydrocarbon seeps, sulfides are concentrated in the sediments. Communities form on patches of oily sediment where sulfides either with the oil or via anoxia caused by microbial oxidation of hydrocarbons and where the combined effects of carbonate precipitation and increased sedimentation cause a gradual mounding of the stratum. (Doyle-PTT)
W91-05917

MULTI-PHASE PARTITIONING OF TRICHLOROETHYLENE AND ORTHO-XYLENE IN WATER SUSPENSIONS OF TUFF: EXPERIMENTS AND ANALYSIS.
Texas Univ. at El Paso. Dept. of Civil Engineering.
H. R. Fuentes, E. H. Essington, J. L. Smith, and W. L. Polzer.
Hazardous Waste and Hazardous Materials HWHME2, Vol. 7, No. 4, p 347-359, Fall 1990,4 fig, 7 tab, 23 ref.

Descriptors: *Air pollution, *Groundwater pollution, *Path of pollutants, *Soil contamination, *Trichoroethylene, *Xylenes, Adsorption, Analytical methods, Chemical analysis, Model studies, Tuff, Volatile organic compounds.

Laboratory batch experiments were conducted to determine the multiphase distribution of trichloroethylene (TCE) and ortho-xylene (O-X) among a simulated groundwater, air and Bandelier tuff. A range of concentrations was added to water in batch reactors at the beginning of the experiments and their partitioning between water and air was measured. Equilibrium was practically reached within the first hour. Estimated adsorption on tuff was effectively modeled by linear and Freundlich isotherms. Henry's Law constants were also calculated for both compounds. Equilibrium data indicate that TCE will partition from an aqueous solution to 64-81% in water, 16-23% in vapor phase and 2-20% in tuff. O-X will partition differently: 77-94% in the water, 3-19% as vapor, and 1-13% in the tuff. Analytical chemistry techniques included both radioanalysis and gas chromatography mass spectrometry (GC/MS). The study highlights the need for adequate techniques and procedures to ensure mass accountability of volatile compounds in the laboratory. (Author's abstract)
W91-05920

ABILITY OF SORBENT MATERIALS TO ADSORB AND RETAIN ORGANIC LIQUIDS UNDER LANDFILL CONDITIONS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
K. W. Brown, J. C. Thomas, M. holder, and J. F. Artiola.
Hazardous Waste and Hazardous Materials HWHME2, Vol. 7, No. 4, p 361-372, Fall 1990, 4 fig, 3 tab, 7 ref.

Descriptors: *Adsorbents, *Cleanup, *Desorption, *Land disposal, *Landfills, *Organic solvents, *Path of pollutants, *Waste disposal, Capillarity, Clay minerals, Diatomaceous earth, Leaching, Percolation tests, Spills.

A variety of sorbent materials is used in accident cleanup to contain spilled chemicals. The ability of these sorbents to retain liquids after being placed in landfills is dependent on capillary retention against the force of gravity, overburden pressure, and leaching by infiltrating water. Three commonly available sorbents were tested for their ability to retain water, acetone, TCE (trichloroethylene) and diesel oil. In all cases the sorbents retained less organic liquids than they did water against capillary drainage. Under certain simulated landfill conditions, retention of all liquids was less than that at saturation, as a result of the combination of gravitational drainage and overburden pressure which depended on the location within the landfill. For water and all the organic liquids tested except TCE, the retention increased, but in some cases only slightly with depth. For TCE the retention decreased with depth. Displacement with water resulted in large fractions of the retained organic liquids being removed from the sorbents. These results indicate that large volumes of pollutants may be released from both saturated and unsaturated sorbents placed in landfills. The use of saturation tests and consolidometer tests alone will not simulate retention under these conditions. (Author's abstract)
W91-05921

ESTIMATION OF THE GROUNDWATER POLLUTION POTENTIAL ON AN AGRICULTURAL WATERSHED.
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
A. S. Rogowski.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 209-230, September 1990. 8 fig, 5 tab, 38 ref.

Descriptors: *Agricultural chemicals, *Agricultural watersheds, *Groundwater pollution, *Solute transport, Model studies, Potential flow.

Using conservative assumptions and worst-case scenarios a strategy is suggested for evaluating the potential impact of water-soluble and interactive agricultural chemicals on a watershed using readily available data. It was shown that a quantity-arrival time distribution could be used to estimate the spatial extent of contributing areas and time of adverse impacts associated with transport of soluble contaminants to the water table. Simplifying assumptions were used to compute distributions of interactive agricultural chemicals within a soil profile as well as their potential concentrations, maxima, and arrival times at the water table. The most questionable assumption this strategy uses concerns the flux rates predicated on a matrix flow model. Should preferential pathways be present, arrival times at the water table and concentrations of contaminants in the groundwater may be most affected. (Author's abstract)
W91-05931

ALUMINIUM ACCUMULATION AND DISTRIBUTION IN THE FRESHWATER CLAMS (UNIONIDAE).
Utrecht Rijksuniversiteit (Netherlands). Dept. of Experimental Zoology.
K. Pynnonen.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 97, No. 1, p 111-117, 1990. 7 fig, 5 tab, 33 ref.

Descriptors: *Acid rain effects, *Aluminum, *Bioaccumulation, *Clams, *Heavy metals, *Mollusks, *Path of pollutants, Acid rain, Hardness, Hydrogen ion concentration, Laboratory methods, Tissue analysis, Toxicity.

During the last few decades, the freshwater chemistry of lakes and rivers of poorly buffered watersheds has been frequently affected by sulfur dioxide emissions. The resulting decrease in pH often leads to a rapid increase in the total metal concentration and in the amount of bioavailable forms of metals. In order to better understand aluminum kinetics and toxicity, freshwater unionids (Anodonta anatina L. and Unio pictorum L.) were exposed to aluminum (300 and 900 microg/L, nominal) in continuous (3 weeks) and fluctuating (24 days) acid exposures. In addition, accumulation was monitored for 2 weeks under semi-static acid (pH 4-5) and circumneutral (pH 6.6-8.3) conditions in hard (35 mg Ca/L) and soft water (3.5 mg Ca/L). A fluctuating exposure of 24 days, consisting of three intermittent pulses which combined low pH (4-5) and high Al (900 microg/L) concentration was also performed. The various organs of A. cygnea, collected from a watershed with relatively high heavy metal concentrations, were analyzed for their Al and Cd concentrations. The ultimate order of the Al and Cd concentration in these clams was identical: kidney > or = midgut gland > or = rest > or = gill > or = mantle. During the 3 weeks of exposure, the Al concentration in the gills and kidney increased linearly, and saturation level was not reached. The Al concentration in the calcium concretion material isolated from the gills was lower than that of the whole organ. An elimination period of 12 weeks was needed to reach the background level of Al in the gills, whereas in the kidney the initial Al concentration was reached after 4 weeks of elimination. In both species the ambient pH had a significant effect on Al accumulation in the gills, whereas the effect of the water hardness was only of minor importance. Rapid elimination of the Al accumulated in the gills of U. pictorum during the episodic 3-day exposure was recorded. (Author's abstract)
W91-05940

POLYCHLORINATED BIPHENYLS (PCBS) IN FISH-EATING SEA BIRDS--I. MOLECULAR FEATURES OF PCB ISOMERS AND CONGENERS IN ADIPOSE TISSUE OF MALE AND FEMALE RAZORBILLS (ALCA TARDA) OF BRITISH AND IRISH COASTAL WATERS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
J. T. Borlakoglu, J. P. G. Wilkins, C. H. Walker, and R. R. Dils.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 97, No. 1, p 151-160, 1990. 3 fig, 5 tab, 21 ref.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Ireland, *Path of pollutants, *Polychlorinated biphenyls, *Scotland, *Water birds, Diphenyldichloroethylene, Food chains, Monitoring, Razorbills, Tissue analysis.

Since fish-eating sea birds are at the apex of marine food chains, measurement of the concentration of polychlorinated biphenyls (PCBs) that have accumulated in their adipose tissue can be used to monitor pollution of the marine environment by PCBs. The concentration of individual PCBs was measured in adipose tissue of male and female razorbills obtained from the Isle of May and the Saltees islands. No significant differences were found in the concentration of total PCBs, which showed positive correlations with the concentration of p,p'-diphenyldichloroethylene in the tissues. Enrichment factors were calculated by comparing the concentration of an individual PCB in the tissue with its abundance in commercial mixtures of PCBs. Eight PCBs, together accounting for 20-65% of the concentration of total PCBs present, had enrichment factors of > 10. They had the common molecular feature of chlorine atoms at adjacent meta-para positions in at least one of the biphenyl rings. Many PCBs had enrichment factors of < 1, suggesting that they had been subjected to metabolism and presumably excretion. They had, in common, the absence of chlorine atoms at the meta-para positions of the biphenyl rings. (See also W91-05942 and W91-05943) (Author's abstract)
W91-05941

POLYCHLORINATED BIPHENYLS (PCBS) IN FISH-EATING SEA BIRDS--II. MOLECULAR FEATURES OF PCB ISOMERS AND CONGENERS IN ADIPOSE TISSUE OF MALE AND FEMALE PUFFINS (FRATERCULA ARCTICA), GUILLEMOTS (URIA AALGA), SHAGS (PHALACROCORAX ARISTOTELIS) AND CORMORANTS (PHALACROCORAX CARBO) OF BRITISH AND IRISH COASTAL WATERS.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
J. T. Borlakoglu, J. P. G. Wilkins, C. H. Walker, and R. R. Dils.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 97, No. 1, p 161-171 1990. 4 fig, 8 tab, 5 ref.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Ireland, *Path of pollutants, *Polychlorinated biphenyls, *Scotland, *Water birds, Diphenyldichloroethylene, Excretion, Metabolism, Tissue analysis.

Polychlorinated biphenyls (PCBs) accumulate in the adipose tissue of fish-eating sea birds at the apex of marine food chains by the ingestion of PCB-contaminated lipid components of food. Therefore, measurement of the concentration of PCBs that have accumulated can be used to monitor pollution of the marine environment. The concentration of individual PCBs was measured in adipose tissue of male and female puffins, shags, guillemots and cormorants obtained from the Isle of May and the Saltees islands. The concentrations of total PCBs showed positive correlations with that of p,p'-diphenyldichloroethylene (DDE) in the tissues. Enrichment factors were calculated by comparing the concentration of an individual PCB in the tissue with its abundance in commercial mixtures of PCBs. Of the 47 individual PCBs identified, five prominent PCBs had enrichment factors considerably > 1 and accounted for approximately 35% of the total concentration of PCBs present. They shared the common molecular feature of chlorine atoms at adjacent meta-para positions in at least one of the biphenyl rings. Many PCBs had enrichment factors of <1, which suggested that they had been subjected to metabolism and presumably excretion. They shared the common feature of the absence of chlorine atoms at the meta-para positions of the biphenyl rings. These results support strongly the structural 'rules' suggested previously for the tendency of individual PCBs to accumulate or to be subjected to metabolism. (See also W91-05942 and W91-05943) (Author's abstract)
W91-05942

POLYCHLORINATED BIPHENYLS (PCBS) IN FISH-EATING SEA BIRDS--III. MOLECULAR FEATURES AND METABOLIC INTERPRETATIONS OF PCB ISOMERS AND CONGENERS IN ADIPOSE TISSUES.
Reading Univ. (England). Dept. of Physiology and Biochemistry.
J. T. Borlakoglu, J. P. G. Wilkins, C. H. Walker, and R. R. Dils.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 97, No. 1, p 173-177, 1990. 6 tab, 12 ref.

Descriptors: *Bioaccumulation, *Fate of pollutants, *Path of pollutants, *Polychlorinated biphenyls, *Structure-activity relationships, *Water birds, Congeners, Ireland, Metabolism, Scotland, Tissue analysis, Toxicity.

Enrichment factors were calculated for several persistent polychlorinated biphenyl (PCB) congeners in the adipose tissue for five species of fish-eating sea birds (female razorbills, puffins, guillemots, shags and cormorants) obtained from the British and Irish coasts. There were no significant differences between the five species in the enrichment factor of individual persistent PCBs compared with persistent congener 153, indicating similar levels of diminished metabolism of this group of congeners. Of the 47 individual PCBs identified, ten congeners had enrichment factors of >1 in all of the species and these accounted for up to 70% of the concentration of total PCBs present. A number of congeners were identified with enrichment factors of <1 compared with their abundance in Aroclor 1260, and very striking differences were observed between the five species in the ratio of non-persistent congeners to the persistent congener 153. These non-persistent congeners share the molecular feature of at least one pair of adjacent unsubstituted meta-para carbon atoms in the rings. This agrees with the molecular 'rule' that congeners with this structural feature are subjected to metabolism by the cytochrome P-450 component of hepatic microsomal monooxygenases. Several PCB isomers and congeners that accumulate in the adipose tissue of these five species are known to bind to the cytoplasmic aryl hydrocarbon (Ah) receptor that has been identified in certain strains of mice and rats. This protein may be involved in the transfer of individual PCBs to the nucleus where they could interact with chromosomal DNA to produce pronounced toxic effects. (See also W91-05941 and W91-05942) (Author's abstract)
W91-05943

SOLUBILIZATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN MICELLAR NONIONIC SURFACTANT SOLUTIONS.
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-05954

SORPTION AND MICROBIAL DEGRADATION OF NAPHTHALENE IN SOIL-WATER SUSPENSIONS UNDER DENITRIFICATION CONDITIONS.
Michigan Technological Univ., Houghton. Dept. of Civil and Environmental Engineering.
J. R. Mihelcic, and R. G. Luthy.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 169-177, January 1991. 6 fig, 3 tab, 50 ref. DOE. Contract DE-AC18-84FC10619.

Descriptors: *Denitrification, *Fate of pollutants, *Microbial degradation, *Naphthalenes, *Path of pollutants, *Soil-water relationships, Kinetic models, Model studies, Soil contamination, Sorption.

Knowledge of the transport and fate of pollutants that have been discharged into soil-water systems is important for understanding the effects of environmental contaminants in the subsurface environment. The microbial degradation of naphthalene under denitrification conditions in batch soil-water suspensions was described by a kinetic model that included consideration of the sorbed-phase solute. This approach combined a retarded radial diffusion model to describe solute sorption and desorption with Michaelis-Menten kinetics to describe the rate of substrate depletion from the bulk aqueous phase, assuming the bacterial concentration was constant over the period of interest and sorbed solute was inaccessible to microorganisms. Experimental measurements showed, and modeling confirmed, that the process of naphthalene sorption-desorption was reversible and the kinetics were rapid compared to those of microbial degradation for the soil particle size employed in the investigation. The rate of naphthalene degradation was independent of nitrate concentration and proportional to the soil-to-water ratio in the range of 1-5 g/50 mL as employed in the batch microbial degradation experiments. Nitrate reduction was related to naphthalene degradation by a stoichiometric conversion factor that assumed end products of carbon dioxide, water, and nitrogen gas. The concepts and assumptions embodied in the coupled desorption-degradation model are potentially significant when the reactions and fate of hydrophobic organic compounds in soil-water systems are evaluated. (White-Reimer-PTT)
W91-05957

USE OF COLLOID FILTRATION THEORY IN MODELING MOVEMENT OF BACTERIA THROUGH A CONTAMINATED SANDY AQUIFER.
Geological Survey, Menlo Park, CA.
R. W. Harvey, and S. P. Garabedian.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 178-185, January 1991. 6 fig, 2 tab, 31 ref.

Descriptors: *Aquifers, *Bacteria, *Groundwater pollution, *Model studies, *Path of pollutants, Filtration models, Filtration theory, Groundwater movement, Massachusetts, Sand aquifers.

The recognition that water-supply well contamination by microbial pathogens is a major cause of waterborne disease outbreaks in the United States and the increasing interest in the use of genetically altered and 'waste adapted' bacteria for aquifer restoration are leading to efforts to model more accurately the transport of bacteria through porous media. A filtration model commonly used to describe removal of colloids during packed-bed filtration in water treatment applications was modified for describing downgradient transport of bacteria in sandy aquifer sediments. The modified model was applied to the results of a small-scale (7m), natural-gradient tracer test and to observations of an indigenous bacterial population moving downgradient within a plume of organically contaminated groundwater in Cape Cod, MA. The model reasonably accounted for concentration histories of labeled bacteria appearing at samplers downgradient from the injection well in the tracer experiment and for the observed 0.25 microm increase in average cell length for an unlabeled, indigenous bacterial population, 0.6 km downgradient from the source of the plume. Several uncertainties were apparent in applying filtration theory to problems involving transport of bacteria in groundwater. However, adsorption (attachment) appeared to be a major control of the extent of bacterial movement downgradient, which could be described, in part, by filtration theory. Estimates of the collision efficiency factor, which represents the physicochemical factors that determine adsorption of the bacteria onto the grain surfaces, ranged from 0.0054 to 0.0097. These results suggest that filtration theory may be useful in a multicomponent description of immobilization in transport models involving bacteria in groundwater. (Author's abstract)
W91-05958

5C. Effects Of Pollution

EFFECTS OF AMMONIA ON PERIPHYTIC COMMUNITIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
B. R. Niederlehner, and J. Cairns.
Environmental Pollution ENPOEK, Vol. 66, No. 3, p 207-221, 1990. 7 fig, 3 tab, 31 ref. USAF Grant 85-0324.

Descriptors: *Ammonia, *Bacteria, *Nitrogen, *Periphyton, *Toxicity, *Water pollution effects, Biomass, Chronic toxicity, Ecosystems, Population exposure.

Laboratory tests were conducted to evaluate the chronic effects of ammonia on periphytic communities. Species richness of the protozoan component of these communities was affected at unionized ammonia concentrations of < or = 1 mg NH(3)/L. A biologically important concentration was defined as the concentration of ammonia affecting 20% of species and was estimated from a concentration-response regression as 0.011 mg/L. A comparable value based on literature reports of chronic toxicity to fish and invertebrates was 0.0126 mg/L. Other non-taxonomic responses were equally sensitive to ammonia. Biomass (ash-free dry weight) and algal biomass (in vivo fluorescence) were significantly reduced even at the lowest tested ammonia treatment, 0.01 mg/L, but the abundance of bacteria was reduced only in the biomass treatment group, 0.43 mg/L. Net community metabolism was reduced in all ammonia treatments. Periphyton communities were affected at levels below the USEPA chronic criterion of 0.027/L. (temperature = 8.8 C and pH = 8.1). Successful maturity or age of the periphytic community affected the amount of biomass and algal biomass, but did not modify sensitivity to ammonia. (Author's abstract)
W91-04942

MONITORING THE TOXICITY OF ORGANIC COMPOUNDS DISSOLVED IN RHINE WATER.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Ecotoxicology, Environmental Chemistry and Drinking Water.
For primary bibliographic entry see Field 5B.
W91-04957

IMPACT OF EUTROPHICATION ON THE SILICATE CYCLE OF MAN-MADE BASINS IN THE RHINE DELTA.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
W. Admiraal, and J. C. Van Der Vlugt.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 23-36, July 1990. 8 fig, 1 tab, 32 ref.

Descriptors: *Chemical interactions, *Eutrophication, *Rhine River, *Silicates, *Water pollution effects, Algal blooms, Biochemistry, Chemical precipitation, Geochemistry, Lake IJsael, Nitrogen, Nutrients, Phosphates, Phytoplankton, Seasonal variation.

The impact of eutrophication on the biochemical cycle of silicate in the Rhine delta was analyzed by: (1) comparing the seasonal variation in river water, stagnant freshwater and coastal seawater, and (2) observations in well controlled experimental reservoirs subjected to different regimes of phosphate precipitation. The high input of dissolved silicate from Rhine water was rapidly depleted in receiving water systems through vigorous phytoplankton (diatom) growth. In reservoirs about 50% of the silicate input was retained over a seven year observation period. The regeneration of silicates immobilized by diatoms was accelerated by very dense blooms of phytoplankton in reservoirs and in Lake IJssel that increased the pH value over 9. The prevailing low ratios of Si/N and Si/P in Rhine water entail the risk of massive blooms of flagellates or cyanobacteria in receiving waters. The 50% reduction of N and PO4 emissions agreed upon in the Rhine Action Plan may reduce, but not eliminate, the risk. (Author's abstract)
W91-04959

PHASES IN THE DEVELOPMENT OF RIVERINE PLANKTON: EXAMPLES FROM THE RIVERS RHINE AND MEUSE.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
E. D. De Ruyter Van Steveninck, B. Van Zanten, and W. Admiraal.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 47-55, July 1990. 9 fig, 35 ref.

Descriptors: *Meuse River, *Phytoplankton, *Plankton, *Population dynamics, *Rhine River, *Water pollution effects, *Zooplankton, Crustaceans, Diatoms, Flow discharge, Population density, River flow, Rotifers, Runoff, Silicates.

Observations on phytoplankton and zooplankton in two hydrographically different rivers were compared in order to discriminate phases in plankton development. Along the longitudinal axis of the Rhine River, a gradual increase in the development of phytoplankton was observed which reached its maximum of about 100 km before the river flows into its artificial sedimentation area. The development of rotifer populations was slightly retarded compared with that of phytoplankton; the highest population densities were only reached in the sedimentation area. Crustaceans developed in significant numbers only when the river water had entered the sedimentation area. Development of zooplankton coincided with a strong decrease in the density of phytoplankton. A similar trend in plankton development was observed in the Meuse River, although in this river the highest densities of phytoplankton and zooplankton already occurred in its middle reaches. Differences in the timing of plankton growth in the two rivers are probably caused by differences in flow regime between both rivers. The Rhine River, which is fed by rainwater and melting glaciers in the Alps, has a relatively constant discharge. On the other hand, the low discharge of the rainfed Meuse River, combined with an increased residence time of the water as a consequence of large numbers of weirs, allows a full cycle of plankton development long before its discharge into the sea. This phenomenon was also reflected in the silicate cycle in the Meuse, where the consumption by plankton diatoms and the regeneration of silicate of deposits seem to be important. In contrast, in the main branches of the Rhine River only the effects of silicate consumption were detectable. (Author's abstract)
W91-04961

REEUWIJK LAKES: A FIVE YEARS WATER QUALITY STUDY IN AN EUTROPHIC ECOSYSTEM.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
J. C. Van Der Vlugt, and S. P. Klapwijk.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 57-67, July 1990. 9 fig, 2 tab, 18 ref.

Descriptors: *Comparison studies, *Eutrophic lakes, *Eutrophication, *Lake restoration, *Phosphorus removal, *Reeuwijk Lakes, *Water quality, Aquatic bacteria, Biomass, Chlorophyll a, Ecosystems, Lake Elfhoeven, Lake Nieuwenbroek, Limnology, Nitrogen, Nutrients, Phosphorus, Rhine River Basin, Seasonal variation, The Netherlands, Zooplankton.

The Reeuwijk Lakes (The Netherlands) present a typical example of eutrophication in the lower Rhine catchment area. In 1986, restoration of these lakes started by reducing the external P-loading. Two lakes: Lake Elfhoeven and Lake Nieuwenbroek, differing in P-load and residence time were selected for monitoring water quality parameters before (1983-1985) and after (1986-1987) restoration measures. Reduction of the external P-loading did not result in lower P-concentrations in both lakes. In contrast, P and N increased. This may have been caused by an increase in diffuse charges. However, seasonal cycles of P and N point to a strong internal loading of nutrients. The concentrations of chlorophyll-a and carotene decreased, indicating a lower phytoplankton biomass. However, as C-phycocyanine concentrations increased the relative abundance of cyanobacteria became higher. Seston concentrations and zooplankton densities did not change. Transparency in the lakes slightly decreased after P-reduction and is far too low for the development of any vegetation of submerged waterplants. The typical differences between both lakes remained after restoration measures. The inverse relationship between the concentrations of chlorophyll-a and total phosphorus at the two sampled stations remained constant. The differences in phytoplankton composition and the zooplankton biomass give a plausible explanation for this inverse relationship between the two stations. Restoring the two lakes after four decades of P-loading cannot be done by simply lowering the external P-load alone. Supplementary in-lake measures may accelerate the restoration process. (Author's abstract)
W91-04962

MODELLING PHOSPHORUS FLUXES IN THE HYPERTROPHIC LOOSDRECHT LAKES.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
J. H. Janse, and T. Aldenberg.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 69-89, July 1990. 14 fig, 33 ref, append.

Descriptors: *Eutrophication, *Lake restoration, *Limnology, *Loosdrecht Lakes, *Model studies, *Phosphorus, *Phosphorus removal, Algae, Carbon, Chemical interactions, Chlorophyll a, Comparison studies, Cycling nutrients, Detritus, Ecosystems, Fish, Interstitial water, Organizations, Phytoplankton, Simulation analysis, Surface water, The Netherlands, Zooplankton.

A dynamic and deterministic model simulates the phosphorus cycle and plankton growth in the shallow, hypertrophic Loosdrecht Lakes (The Netherlands) before and after restoration measures. Beside inorganic phosphorus (SRP) in both the surface water and the interstitial water, the model comprises three algal groups, zooplankton, fish, detritus, zoobenthos and upper sediments (all modeled both in carbon and phosphorus). Within the model system, the phosphorus cycle is completely closed. Carbon and phosphorus are described independently, so that the dynamics of the P/C ratios can be modeled. Sediment processes are described in a simplified form. Simulated values are largely within the observed range. The detrital fraction of the seston (=phytoplankton + detritus) varies from 50% to 60% in summer, to about 90% in the winter. SRP in the surface water is very low during most of the year. Sensitivity for external phosphorous input is larger for algal and detrital P than for algal and detrital C and chlorophyll-a. So the P/C ratio of the seston decreases following restoration measures as is observed in the lakes, while the much higher P/C ratios of zooplankton and fish remain constant. Phosphorus mobilization from the sediment decreases with decreasing external input. Adaptation of the model system to the reduced loading takes place within about two years. Sources of uncertainty in the model include the limited knowledge on selective grazing as well as on mortality and mineralization processes. (Author's abstract)
W91-04963

MODEL ON THE COMPETITION BETWEEN TWO MACROPHYTE SPECIES IN ACIDIFYING SHALLOW SOFT-WATER LAKES IN THE NETHERLANDS.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Ecotoxicology, Environmental Chemistry and Drinking Water.
F. G. Wortelboer.
Hydrobiological Bulletin HYBUD9, Vol. 24, No. 1, p 91-107, July 1990.8 fig, 4 tab, 26 ref, append.

Descriptors: *Acid lakes, *Acid rain effects, *Acidification, *Competition, *Limnology, *Macrophytes, *The Netherlands, *Water pollution effects, Aquatic plants, Rushes, Species composition, Surface water.

To predict changes in vegetation as a result of acidification in Dutch lakes, a mathematical model was formulated which describes the growth of Littorella uniflora and Juncus bulbosus, species characteristic for nonacidified and acidified situations, respectively. The 2 species compete for light, CO2 and nutrients. The model integrates current knowledge about the ecophysiology of the species. The results generated by the model are similar to field data concerning dominance of the species in different habitats. L. Uniflora is able to grow well under environmental conditions associated with acidification as long as it is not outcompeted by J. bulbosus. (Author's abstract)
W91-04964

EFFECTS OF INCREASING ACIDITY ON AQUATIC PROTOZOAN COMMUNITIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
B. R. Niederlehner, and J. Cairns.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 183-196, 1990. 5 fig, 6 tab, 44 ref. Air Force Office of Scientific Research Grant No. 85-0324.

Descriptors: *Acid rain effects, *Acidification, *Chronic toxicity, *Ecological effects, *Protozoa, *Species diversity, *Water pollution effects, Acidity, Algae, Aquatic fungi, Bacteria, Hydrogen ion concentration, Taxonomy.

Laboratory tests were conducted to evaluate the chronic effects of increased acidity on protozoan communities. Taxonomic richness of the protozoan component of these communities was severely affected at pH < or = 5.3. Taxonomic composition was significantly affected at much higher pH. A permissible concentration was defined as the pH affecting no more than 20% of the species, and estimated from concentration-response regression as 6.92 (5.92 to 8.04) pH units. Bacterial abundance decreased at pH levels < or = 5.34 pH units. A similar value estimated from more conventional chronic toxicity tests were 6.28 (6.16 to 6.45) pH units. Other nontaxonomic responses (e.g., biomass, algal biomass, fungal biomass, net oxygen metabolism) were not sensitive to increases in acidity. (Author's abstract)
W91-04976

EFFECTS OF OZONE AND ACIDIC PRECIPITATION ON THE GROWTH AND PHOTOSYNTHESIS OF RED SPRUCE AFTER TWO YEARS OF EXPOSURE.
Boyce Thompson Inst. for Plant Research, Ithaca, NY.
R. J. Kohut, J. A. Laurence, P. G. Amundson, R. M. Raba, and J. J. Melkonian.
Water, Air and Soil Pollution WAPLAC, Vol. 51, No. 3/4, p 277-286, 1990. 4 tab, 25 ref. EPA-USDA Forest Service Forest Response Program Grant No. 23-115, EPRI Contract RP2799-1.

Descriptors: *Acid rain effects, *Air pollution effects, *Ozone, *Plant growth, *Spruce trees, Acidity, Ecological effects, Hydrogen ion concentration, Photosynthesis, Seedlings, Simulation analysis, Stress.

Although the agents responsible for the decline of red spruce on high elevation sites in the northeast are not known, O3 and acidic rain are considered to be possible contributing stresses. Research from the second year of a three year study is presented to evaluate and quantify the influences of O3 and acid precipitation on seedling red spruce. Two year old red spruce seedlings were exposed to O3 at 4 levels (approximately 0.5, 1.0, 1.5, and 2.0 times ambient O3 concentration) and simulated acid precipitation at 3 levels (pH 3.1, 4.1, and 5.1) in open top chambers. The exposures occurred during June through October, 1988 after the seedlings had been exposed to the pollutants the previous year. At three intervals during the exposure period, seedlings were harvested and the effects of the pollutant treatments were assessed by measuring the length of the 1988 terminal shoot, the number and length of branches, the dry mass of stems, needles and roots, and rate of photosynthesis. There were no significant effects of O3 on any of the growth variables or on photosynthesis. There was a significant effect of pH on photosynthesis. Rates of photosynthesis increased as acidity

of the treatment increased. However, the higher rates of photosynthesis were not reflected in an increased biomass of the seedlings. Significant O3 by pH interactions occurred for several growth variables. (Author's abstract)
W91-04981

DNA DAMAGE DETERMINATION BY THE ALKALINE ELUTION TECHNIQUE IN THE HAEMOLYMPH OF MUSSEL MYTILUS GALLOPROVINCIALIS TREATED WITH BENZO(A)PYRENE AND 4-NITROQUINOLINE-N-OXIDE.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
N. Bihari, R. Batel, and R. K. Zahn.
Aquatic Toxicology AQTODG, Vol. 18, No. 1, p 13-22, November 1990. 3 fig, 3 tab, 36 ref.

Descriptors: *Benz(a)pyrene, *DNA, *Laboratory methods, *Mussels, *Nitroquinoline, *Water pollution effects, Chemical analysis, Genotoxicity, Organic compounds, Toxicity.

The ability of benzo(a)pyrene (BaP) and 4-nitroquinoline-N-oxide (NQO) to induce DNA breakage in hemolymph of the mussel Mytilus galloprovincialis was studied using an alkaline elution assay. The elution of hemolymph DNA from control animals increased from pH 12.1-12.8, suggesting that DNA alkali-labile sites are already present in the hemolymph. The difference between control and treated mussels is sufficient at pH 12.3 that additional alkali-labile sites and single strand breaks caused by BaP and NQO can be measured. Elution of hemolymph DNA from both BaP and NQO treated mussels, increased in a dose dependent manner after 1.5 hours, followed by a decrease in the elution rate depending on dose, after 48 hours for BaP and 5 days for NQO. The results indicate that the repair of DNA in mussel hemolymph is significant and dependent on the dose of chemical applied. DNA damage in BaP treated mussels could be explained by the formation of peroxides and/or radicals during low BaP metabolism, and their effects on DNA. (Author's abstract)
W91-04991

EFFECTS OF SEDIMENT-ASSOCIATED COPPER ON ECOLOGICAL STRUCTURE AND FUNCTION OF AQUATIC MICROCOSMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
V. S. Scanferlato, and J. Cairns.
Aquatic Toxicology AQTODG, Vol. 18, No. 1, p 23-34, November 1990. 2 fig, 3 tab, 24 ref.

Descriptors: *Copper, *Path of pollutants, *Sediment contamination, *Toxicity, *Water pollution effects, Adenosine triphosphate, Biomass, Chlorophyll a, Ecotoxicology, Heavy metals, Productivity, Respiration.

The fate and effects of sediment-associated copper (Cu) on the structure and function of aquatic communities were studied in aquatic microcosms that were constructed from naturally derived water and sediment. Sediment was spiked with nominal Cu concentrations of 0, 10, 100, or 1000 mg/kg dry sediment. Copper partitioning between sediment particles, pore water, and overlying water was followed in an 8 week long experiment. Most of the added Cu was bound to sediment particles. There was no evidence that the structural or functional measures were affected in microcosms containing the nominal concentration of 10 mg Cu/kg sediment. In 100 mg/kg microcosms, with Cu concentrations of about 0.5 mg/L of overlying water, chlorophyll-a content and respiration significantly decreased compared to the control. The failure to detect significant impacts on other structural and functional attributes probably resulted from the high variability of the nontaxonomic attributes and the displacement of species sensitive to Cu by the tolerant species. In microcosms containing the nominal concentration of 1000 mg Cu/kg (about 20 mg Cu/L of overlying water), the community showed a significant decrease in production, respiration, respiration/biomass ratio, ATP, and chlorophyll-a; the assimilation ratio and autotrophic index were significantly higher than in the control. Results of this study may be useful in predicting the impact of similar toxic stress on natural ecosystems. (Author's abstract)
W91-04992

SUBLETHAL PHYSIOLOGICAL CHANGES IN FRESHWATER CRAYFISH, ASTACUS ASTACUS, EXPOSED TO NITRITE: HAEMOLYMPH AND MUSCLE TISSUE ELECTROLYTE STATUS, AND HAEMOLYMPH ACID-BASE BALANCE AND GAS TRANSPORT.
Odense Univ. (Denmark). Biological Inst.
F. B. Jensen.
Aquatic Toxicology AQTODG, Vol. 18, No. 1, p 51-60, November 1990. 5 fig, 16 ref.

Descriptors: *Animal physiology, *Crayfish, *Nitrites, *Sublethal effects, *Toxicity, *Water pollution effects, Hemolymph, Physiological ecology, Tissue analysis.

Crayfish, Astacus astacus, were exposed to 0.8mM environmental nitrite for up to seven days to investigate nitrite-induced pertubations of crustacean homeostasis. Nitrite accumulation in the hemolymph to 8-10 mM within two days, whereafter the extracellular concentration remained constant. This was associated with a substantial decrease in hemolymph chloride and a smaller decrease in sodium, whereas other hemolymph ions (potassium, calcium, magnesium, bicarbonate and lactate) were unchanged. In muscle, a pronounced decrease in potassium concentration occurred, whereas sodium, calcium and magnesium concentrations were unaffected. It is proposed that K efflux from intercellular compartments constitute a general response to nitrite. The extracellular acid base status changed toward a respiratory alkalosis. Hemolymph PO2 increased and the hemocyanin concentration decreased. The respiratory pigment itself appeared only marginally affected by nitrite. Oxygen transport accordingly was not severely perturbed, and lactate levels remained low. (Author's abstract)
W91-04994

INCIDENT OF SOUTHERN OCEAN OIL POLLUTION: EFFECTS OF A SPILLAGE OF DIESEL FUEL ON THE ROCKY SHORE OF MACQUARIE ISLAND (SUB-ANTARCTIC).
University of New England, Armidale (Australia). Dept. of Zoology.
A. Pople, R. D. Simpson, and S. C. Cairns.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 5, p 603-620, 1990. 11 fig, 3 tab, 23 ref, append.

Descriptors: *Antarctic, *Macquarie Island, *Marine environment, *Oil spills, *Water pollution effects, Algae, Ecological effects, Invertebrates, Littoral zone, Oil pollution, Population density.

On December 3, 1987, the Australian resupply ship Nella Dan ran aground at Macquarie Island, releasing approximately 270,000 L of oil, mostly light marine diesel, into the sea. This represented one of the few spills to have occurred in southern hemisphere cold waters. Following the spill, thousands of marine invertebrates were washed up dead on beaches along 2 km of the shore. Twelve months after the spill, a study was conducted to examine the shore community in 5 zones at 2 oil affected and two control locations. Three sites were examined within each of these locations. Densities of marine invertebrates appear to have been markedly reduced in the lower littoral and sublittoral zones in the vicinity of the wreck. In the upper littoral zones, algal cover and invertebrate abundance were similar at oil-affected and control locations. The significance of the spill and its long-term effects require continued monitoring. Such monitoring will add to the knowledge of long-term oil pollution effects on marine communities. Densities of affected invertebrates, particularly N. macquariensis, should be determined, preferably in the Lower Red zone. In addition, knowledge of the size classes (juvenile vs. adult) of recolonizing individuals may indicate their origin. Monitoring should be conducted at least at the heavily oil affected location and at control sites. (Lantz-PTT)
W91-05005

ORGANOCHLORINE CONTAMINANTS IN EGGS AND TISSUE OF WOOD DUCKS FROM MISSISSIPPI.
Mississippi Cooperative Fish and Wildlife Research Unit, Mississippi State.
For primary bibliographic entry see Field 5B.
W91-05009

ACUTE TOXICITY TO FRESHWATER BENTHIC MACROINVERTEBRATES OF FLUORIDE ION (F-) IN SOFT WATER.
Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.
J. A. Camargo, and J. V. Tarazona.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 883-887, December 1990. 3 tab, 16 ref.

Descriptors: *Benthic environment, *Fluorides, *Macroinvertebrates, *Toxicity, *Water pollution effects, Acute toxicity, Aquatic insects, Daphnia, Freshwater, Spain, Water quality standards.

Fluoride acute toxicity was investigated in five species of aquatic insect larvae which are ordinary benthic macroinvertebrates in rivers from the Iberian Peninsula. Last instar of trichoptera aquatic larvae were collected from fluoride unpolluted areas of Spanish rivers: Chimarra marginatta Linnaeus, Hydropsyche lobata MacLachlan and Hydropsyche bulbifera MacLachlan from Rio Aulencia (Madrid), Hydropsyche exocellata Dufor from Rio Jarama (Madrid), and Hydropsyche pellucidula Curtis from Rio Duration (Segovia). In the laboratory, test organisms were randomly selected and placed into test aquaria. Fluoride concentrations were monitored daily. There were no dead animals in sodium and conductivity controls after 96 hour exposures to sodium chloride. Simple comparison of median lethal concentrations for the five species indicate that H. bulbifera and H. exocellata are the most sensitive species to fluoride, since their 96-hr LC50s are smallest and their 95% confidence limits do not significantly overlap with the 95% confidence limits of the other species tested. This may indicate that some freshwater benthic macroinvertebrates like H. bulbifera and H. exocellata can be more sensitive than freshwater fish to fluoride ion. Water quality criteria, based on the more sensitive species, should provide adequate protection to fluoride pollution. (Lantz-PTT)
W91-05010

SEASONAL LETHALITY OF PENTACHLOROPHENOL TO JUVENILE ATLANTIC SALMON.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
L. E. Burridge, and K. Haya.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 888-892, December 1990. 1 tab, 10 ref.

Descriptors: *Laboratory methods, *Pentachlorophenol, *Salmon, *Seasonal variation, *Toxicity, *Water pollution effects, Hydrogen ion concentration, Lethal limit, Organic compounds, Phenols, Temperature, Zinc.

Pentachlorophenol (PCP) is a broad spectrum biocide. It has been suggested that pentachlorophenol and its sodium salt, sodium pentachlorophenate, be used as a reference toxicant for fish studies. Results are reported of a 2-year study in which juvenile Atlantic salmon (Salmo salar) were exposed to PCP in a series of lethality tests to determine if the lethality of this compound is effected by the time of year of exposure. There appears to be no difference in lethality of PCP to juvenile Atlantic salmon with season. The range of LC50 values (58 to 127 microg/L) suggest that there is some difference in sensitivity; however, there is no clear seasonal trend. No significant size effects on lethality were apparent. A linear regression of weight versus LC50 (over a 2-year period) reveals no significant correlation between these factors ($p >$

.05). Any significant differences in lethality measurements would then be attributed to lab or stock differences or indicative of other mitigative factors such as stress. (Lantz-PTT)
W91-05011

TOXICITY OF MERCURY TO THE FRESHWATER MALE AND FEMALE FIELD CRABS, PARATELPHUSA HYDRODROMOUS (HERBST) (DECAPODA: BRACHYURA).
Andhra Univ., Waltair (India). Dept. of Zoology.
K. V. V. Ananthalakshmikumari, K.
Shyamasundari, and K. H. Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 900-906, December 1990. 2 fig, 3 tab, 18 ref.

Descriptors: *Bioindicators, *Crabs, *Mercury, *Toxicity, *Water pollution effects, Crustaceans, Ecotoxicology, Heavy metals, Lethal limit, Mortality.

Freshwater organisms are known to be susceptible to mercury contaminants, but there is no detailed account on the acute toxicity of mercury to the crab Paratelphusa hydrodromous. This work was designed to calculate the LC50, standard error values, and their 95% fiducial limits of mercury to P. hydrodromous under static conditions. Static bioassays were conducted on the freshwater crab P. hydrodromous. The heavy metal used for the test was HgCl2 (analytical grade). There was a difference in the sensitivity of male and female crabs when exposed to mercury. The lethal concentrations of mercury were higher for females than males, which may be attributable to the lipophilic compounds stored in fat deposits which act as a reservoir, temporarily removing the insecticide from circulation. The mortality of mercury in both sexes increases with increased time of exposure. Lethal concentration values decrease with exposure time. Because of their sensitivity to many pollutants, crabs should be used as predictors of adverse conditions of the environment. (Lantz-PTT)
W91-05013

TRACE AND HEAVY METALS IN THE OYSTER CRASSOSTREA VIRGINICA, SAN ANDRES LAGOON, TAMAULIPAS, MEXICO.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.
For primary bibliographic entry see Field 5B.
W91-05014

TOXICITY TESTING WITH FRESHWATER ALGAE IN RIVER PERIYAR (INDIA).
Cochin Univ. (India). School of Environmental Studies.
C. M. Joy.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 915-922, December 1990. 2 fig, 4 tab, 21 ref.

Descriptors: *Algae, *Industrial wastewater, *Periyar River, *Toxicity, *Water pollution effects, Bioassay, Ecotoxicology, India, Lethal limit.

An investigation was conducted to determine the effect of a fertilizer factory effluent on two species of unicellular algae. A prediction for the probable effect of continued discharge of waste is proposed. Laboratory studies were conducted on axenic cultures of two freshwater algae: Nitzschia palea and Oocystis pusilla isolated from the upstream area of the Periyar River. Preliminary range finding tests revealed that the effluent was inhibitory to the growth of the test species and their relative tolerance varied. The effluent significantly inhibited the rate of cell multiplication and production of chlorophyll-a, -c, and carotenoids of N. palea at all concentrations tested. Inhibition of growth (EC50) occurred at 74% concentration of the effluent. The growth of O. pusilla was stimulated by 5% effluent and at 10% was similar to that of the control. As the concentration increased, the growth rate declined. Fifty percent of growth was observed at 21% effluent concentration. These results suggest that the response to a particular industrial effluent is dependent upon species as well as concentration. The industrial effluents affect primary production either by increased light attenuation or direct phytotoxicity or physiological stress. The results further indicate that the discharge in the Periyar River during premonsoon months is inadequate to dilute the effluent to a safe level. (Lantz-PTT)
W91-05015

TOXICITY OF CHAUTAUQUA LAKE BRIDGE RUNOFF TO YOUNG-OF-THE-YEAR SUNFISH (LEPOMIS MACROCHIRUS).
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. Adams Kszos, J. D. Winter, and T. A. Storch.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 45, No. 6, p 923-930, December 1990. 2 fig, 2 tab, 22 ref.

Descriptors: *Chautauqua Lake, *Deicers, *Highway effects, *Nonpoint pollution sources, *Sunfish, *Toxicity, *Water pollution effects, Bioassay, Cadmium, Heavy metals, Highways, Sodium chloride, Urban runoff, Zinc.

Runoff from roadways is a common nonpoint source of water pollution. Ice-control chemicals contribute significantly to nonpoint water pollution in the snow belt region of the United States. The annual use of highway deicers, for example is about 8-9 million metric tons of NaCl, 0.3 million metric tons of CaCl2, and 7 million metric tons of abrasives. Several studies suggest that deicing salts contribute to increased concentrations of chloride in receiving waters. In addition, many studies have shown that NaCl and metals can be toxic to fish. A study of Chautauqua Lake Bridge, in western New York, runoff toxicity on sunfish further illustrates this toxicity. NaCl appeared to be the major contributor to the toxicity of runoff from the Chautauqua Lake bridge in laboratory bioassays. However, concentrations of Zn and Cd present in the 50% winter runoff were in the range reported to be toxic to fish, and may have been additive or synergistic with the NaCl toxicity in the laboratory bioassays. Because runoff from the Chautauqua Lake bridge will be greatly diluted when it enters the lake, it is unlikely that the bridge runoff will be toxic to fish in the lake. However, if runoff comparable to that which enters Chautauqua Lake during the winter were to enter a much smaller body of water, the NaCl would probably cause significant harm to freshwater organisms. (Lantz-PTT)
W91-05016

NON-O GROUP 1 VIBRIO CHOLERAE: A LOOK AT THE EPIDEMIOLOGY OF AN OCCASIONAL PATHOGEN.
Maryland Univ. at Baltimore. School of Medicine.
J. G. Morris.
Epidemiologic Reviews EPIRD7, Vol. 12, p 179-191, 1990. 6 tab, 85 ref.

Descriptors: *Enteric bacteria, *Epidemiology, *Human diseases, *Pathogenic bacteria, *Water pollution effects, Aquatic bacteria, Gastroenteritis, Human pathogens, Shellfish, Vibrio, Water pollution.

Non-O1 Vibrio cholerae is a ubiquitous environmental isolate. The principle reservoir for non-O1 V. cholerae appears to be the aquatic environment; non-O1 strains are part of the normal autochthonous bacterial flora in estuarine environments. It is a common contaminant of shellfish, and in the developing world, it is frequently isolated from food and water. Asymptomatic carriage rates approaching 4% have been described among persons involved in high-risk activities, such as eating oysters in New Orleans or going on a pilgrimage to Mecca. The actual occurrence of the disease appears to be much less common. Non-O1 V. cholerae is an 'occasional' pathogen which may be responsible for outbreaks or high frequency of isolation in certain areas at specific times but which generally ranks as a minor cause of diarrheal disease. While host susceptibility and infectious dose may help explain the relatively infrequent occurrence of non-O1 V. cholerae-associated disease, it also appears likely that only a small minority of strains carry the necessary virulence factors to cause gastroenteritis. There does not appear to be a single mechanism by which the organisms cause diarrhea; it is likely that a heterogeneous pattern of virulence mechanisms, similar to that seen among diarrhea-genic E. coli, will be found. (MacKeen-PTT)
W91-05037

EPISODIC POLLUTION: CAUSES, TOXICOLOGICAL EFFECTS AND ECOLOGICAL SIGNIFICANCE.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
C. P. McCahon, and D. Pascoe.
Functional Ecology FECOE5, Vol. 4, No. 3, p 375-383, 1990. 3 fig, 2 tab, 67 ref.

Descriptors: *Acid rain effects, *Environmental effects, *Testing procedures, *Toxicology, *Water pollution, *Water pollution effects, Aluminum, Aquatic organisms, Bioindicators, Dissolved oxygen, Episodic pollution, Farm wastes, Field tests, Invertebrates, Laboratory methods, Liming, Simulation analysis, Toxicity.

The importance of episodic pollution is discussed along with methods for field and laboratory simulations of such events. In episodic toxicity testing procedures, a range of factors can influence the organism and ecosystem response to a toxicant: duration, concentration and amplitude of the episode, frequency of event, absorption, degradation and recovery rates. Since the occurrence of episodic pollution incidents generally cannot be predicted, its study relies heavily on simulations. Field simulations of acid episodes have indicated that aluminum at low pH is the most damaging combination of the conditions tested and that fish were less tolerant than invertebrates. The practice of adding limestone to chronically acid streams in an attempt to raise the pH and reduce aluminum toxicity was shown to have limited effectiveness in simulation studies. Field simulations of farm waste pollution indicated that stoneflies and mayflies were the most sensitive to conditions of reduced dissolved oxygen. Laboratory simulations have been used to study post-exposure lethal and sublethal responses to pulses of toxicants such as cadmium. It is recommended that modifications of standard toxicity tests be made to allow the study of brief exposure to toxicants to be incorporated in the hazard evaluation process. (MacKeen-PTT)
W91-05039

INTERACTIONS BETWEEN THE SURFACE OF RAINBOW TROUT, ONCORHYNCHUS MYKISS, AND WATERBORNE METAL TOXICANTS.
Dundee Univ. (Scotland). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.
W91-05040

PRELIMINARY OBSERVATIONS ON THE ECOLOGICAL RELEVANCE OF THE GAMMARUS 'SCOPE FOR GROWTH' ASSAY: EFFECT OF ZINC ON REPRODUCTION.
Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
For primary bibliographic entry see Field 5A.
W91-05041

CLONAL VARIATION IN GENERAL RESPONSES OF DAPHNIA MAGNA STRAUS TO TOXIC STRESS: I. CHRONIC LIFE-HISTORY EFFECTS.
Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
D. J. Baird, I. Barber, and P. Calow.
Functional Ecology FECOE5, Vol. 4, No. 3, p 399-407, 1990. 6 fig, 20 ref. NERC Grant TFS/86/AnE/4.

Descriptors: *Bioindicators, *Cadmium, *Daphnia, *Heavy metals, *Pesticide residues, *Water pollution effects, Acute toxicity, Chronic toxicity, Genetic variation, Lethal limit, Life history studies, Waterfleas.

The responses of different genotypes of the parthenogenetic cladoceran Daphnia magna Straus to acute and chronic exposures of cadmium and the non-polar organic pesticides residue, 3,4-dichloroaniline (DCA), were investigated. Large differences in interclonal responses were observed in acute tolerance to cadmium, with LC50 values ranging from 0.06 to >100 ppb. Interclonal variation in chronic stress tolerance was also observed, although in this case differences, though significant, were relatively small (effective concentrations 25-50 ppb for DCA and 0.6-6.0 ppb for cadmium). Deleterious effects on life-history variables and energy allocation followed the same pattern for all clones exposed to both toxicants. It is concluded that specific mechanisms (e.g. metallothionein detoxification of heavy metals) dominate differences in acute responses, whereas general mechanisms (relating to energy supply and demand) dominate in chronic responses. (See also W91-05043) (Author's abstract)
W91-05042

CLONAL VARIATION IN GENERAL RESPONSES OF DAPHNIA MAGNA STRAUS TO TOXIC STRESS: II. PHYSIOLOGICAL EFFECTS.
Sheffield Univ. (England). Dept. of Animal and Plant Sciences.
I. Barber, D. J. Baird, and P. Calow.
Functional Ecology FECOE5, Vol. 4, No. 3, p 409-414, 1990. 4 fig, 21 ref. NERC Grant TFS/86/AnE/4.

Descriptors: *Bioindicators, *Cadmium, *Daphnia, *Heavy metals, *Pesticide residues, *Water pollution effects, Acute toxicity, Chronic toxicity, Ecotoxicology, Genetic variation, Oxygen consumption, Physiology, Proteins, Waterfleas.

Changes in protein turnover and their metabolic costs are thought to play an important role in the general response of animals to toxicants. Making use of genetic differences in the tolerance of different clones of Daphnia magna Straus, a parthenogenetic cladoceran extensively used in ecotoxicological tests, responses to cadmium and the non-polar organic pesticide residue, 3,4-dichloroaniline (DCA), were investigated. Irrespective of tolerances, there was evidence that all clones showed an increase in protein turnover and associated increases in respiratory maintenance costs under toxic stress, indicating the deployment of a general stress response. One clone that was least sensitive to DCA showed a more extreme form of these responses. It was concluded that there is considerable convergence between clones of Daphnia magna in metabolic responses to chronic exposure to toxicants. (See also W91-05042) (Author's abstract)
W91-05043

OXYRADICAL PRODUCTION AS A POLLUTION-MEDIATED MECHANISM OF TOXICITY IN THE COMMON MUSSEL, MYTILUS EDULIS L., AND OTHER MOLLUSKS.
Plymouth Marine Lab. (England).
D. R. Livingstone, P. Garcia Martinez, X. Michel, J. F. Narbonne, and S. O'Hara.
Functional Ecology FECOE5, Vol. 4, No. 3, p 415-424, 1990. 2 tab, 66 ref.

Descriptors: *Enzymes, *Mollusks, *Toxicity, *Water pollution effects, Benz(a)pyrene, Herbicides, Hydrogen peroxide, Hydroxyl radical, Mussels, Oxidation-reduction, Oxyradicals, Paraquat, Pesticide toxicity, Polycyclic aromatic hydrocarbons, Redox cycling, Superoxide anion radical.

Normal and pollution-enhanced oxyradical (superoxide anion radical, hydrogen peroxide, hydroxyl radical) production in mollusks are reviewed. Additionally, antioxidant enzyme responses and lipid peroxidation effects in the digestive gland of Mytilus edulis L. exposed to 50 ppb benzo(a)pyrene (BaP) or 1 ppm of the model redox recycling compound menadione were investigated. Digestive gland microsomes support NADPH-dependent and NADH-dependent oxyradical generation and the rates of production are increased by redox cycling compounds (menadione, nitrofurantoin, paraquat). Antioxidant enzymes (superoxide dismutase (SOD), catalase, glutathione peroxidase, NAD(P)H-DT-diaphorase) and free radical scavengers (glutathione, vitamins A, C and E, beta-carotene) are present in molluscan tissues. Potential sources of pollutant-enhanced oxyradical generation include uptake of redox cycling xenobiotics, elevation of cytochrome P-450 and cytochrome P-450 reductase, and biotransformation of BaP and other polycyclic aromatic hydrocarbons to redox cycling quinones. Transient increases in antioxidant enzymes occurred with exposure of bivalves to paraquat, BaP or menadione. Increases in lipid peroxidation also were indicated. Future studies should concentrate on demonstrating oxyradical production in vivo and on examining the link between oxidative damage and animal fitness. (Author's abstract)
W91-05044

EFFECTS OF TBT CONTAMINATION ON NUCELLA POPULATIONS.
Liverpool Univ., Port Erin (England). Dept. of Marine Biology.
S. K. Spence, G. W. Bryan, P. E. Gibbs, D. Masters, and L. Morris.
Functional Ecology FECOE5, Vol. 4, No. 3, p 425-432, 1990. 4 fig, 1 tab, 34 ref. NERC Grant TFS/86/AnE/2, Dept. of Environment Contracts DGR 480/51, PECD 7/7/113 and 226, and EEC Contracts ENV-686-UK(H) and ENV-687-UK(H).

Descriptors: *Antifoulants, *Aquatic animals, *Bioindicators, *Coasts, *Organotin compounds, *Path of pollutants, *Water pollution effects, England, Gastropods, Imposex, Isle of Man, Physiology, Population density, Population exposure.

Leachates from tributyltin (TBT) based antifouling paints have been shown to induce the superimposition of male characteristics on females (imposex) in the dogwhelk, Nucella lapillus (L.). The use of imposex in Nucella as an indicator of TBT pollution showed widespread TBT contamination in Britain. Contamination is localized close to the source in most of the country, with the exception of the south coast where boating activity is intense. Investigation of paired shores along an uncontaminated and contaminated wave exposure gradient on the Isle of Man showed natural changes that occur in population structure and the decline in abundance due to TBT contamination. Barnacle and fucoid algae cover estimates suggested that dogwhelk abundance declines with reduced prey abundance. On semi-exposed shores the natural cycle of barnacle/fucoid domination may be affected by a decline in dogwhelk population. It is concluded that imposex in dogwhelks may be used as an ecological index of TBT pollution. (MacKeen-PTT)
W91-05045

ASSESSING THE IMPACT OF TIN AND TBT IN ESTUARIES AND COASTAL REGIONS.
Plymouth Marine Lab. (England).
W. J. Langston, G. W. Bryan, G. R. Burt, and P. E. Gibbs.
Functional Ecology FECOE5, Vol. 4, No. 3, p 433-443, 1990. 5 fig, 2 tab, 17 ref. Dept. of the Environment Grants PECD 7/7/226 and PECD 7/8/103.

Descriptors: *Antifoulants, *Aquatic animals, *Bioindicators, *Estuarine sediments, *Organotin compounds, *Sediment contamination, *Tin, *Water pollution effects, Bioavailability, Clams, Coasts, England, Estuaries, Gastropods, Imposex, Isle of Wight, Toxicity.

The environmental effects of tin and tributlytin (TBT) pollution in a coastal area in southwest England were examined. Total Sn concentrations in excess of 1000 microg/g are not uncommon in estuarine sediments of Restronguet Creek and the Hayle and Helford estuaries. For the majority of sites, Sn tissue burdens correlated most closely with Sn levels in 1 N HCl sediment extracts. However, in areas of high boating activity, TBT from antifouling paints contributed a much higher bioaccumulation potential relative to inorganic Sn. Deleterious effects caused by sediment-bound Sn were strongly related to chemical speciation. Abundance of clams (Scrobicularia plana) appeared to have declined substantially in TBT-contaminated areas. Levels of TBT well in excess of the environmental quality target level of 20 ng/L were measured for waters adjacent to the Isle of Wight. Intensities of imposex in dogwhelks (Nucella lapillus (L.)), expressed as relative penis size (RPS), in general were found to reflect organotin concentrations in tissue. However, TBT levels in tissues reflected relatively recent exposure, while RPS indices were indicative of exposure over several years. Results indicated that TBT has been gradually eliminating N. lapillus from the Isle of Wight. It is concluded that measurement of reproductive abnormalities in dogwhelks provides an extremely sensitive and specific means of monitoring the biological impact of TBT in coastal waters. (MacKeen-PTT)
W91-05046

PHYSIOLOGICAL AND MORPHOGENETIC EFFECTS OF MONOPHENYLTIN TRICHLORIDE ON OCENEBRA ERINACEA (L).
Southampton Univ. (England). Dept. of Oceanography.
L. E. Hawkins, and S. Hutchinson.
Functional Ecology FECOE5, Vol. 4, No. 3, p 449-454, 1990. 4 fig, 23 ref.

Descriptors: *Marine pollution, *Mollusks, *Organotin compounds, *Water pollution effects, Acclimatization, Animal morphology, Antifoulants, Aquatic animals, Devon, England, Enzymes, Imposex, Physiology, Solent, Sublethal effects.

The sub-lethal effects of monophenyltin (MPhT), a less active form of organotin, on the marine mollusk Ocenebra erinacea were investigated. Specimens were obtained from two sites on the British coast: south Devon, where sediments were expected to carry a lower tin burden, and western Solent, where sediments contained higher tin concentrations. Experimental animals were exposed to 0.2 microgMPhT/L for 10 days. Unexposed animals from the Devon site had significantly greater diffusional water permeability than did MPhT-exposed animals from either site and control animals from Solent. Total ATPase activities were greater in control than treated animals from both sites. Carbonic anhydrase activity was reduced in the MPhT-treated animals from the Devon site, relative to control levels. Exposure to MPhT increased penile length in males and females from the Devon site but a reduction was observed in animals from western Solent. It is concluded that exposure to sub-lethal concentrations of MPhT causes acute changes in the control of hydromineral regulation and chronic changes manifested as abnormal penile morphogenesis. It is suggested that long-term acclimation to organotin pollution may have occurred in Solent animals. (MacKeen-PTT)
W91-05048

INFLUENCE OF METAL AND TEMPERATURE STRESS ON THE IMMUNE SYSTEM OF CRABS.
Victoria Univ. of Manchester (England). Dept. of Environmental Biology.
R. Truscott, and K. N. White.
Functional Ecology FECOE5, Vol. 4, No. 3, p 455-461, 1990. 4 fig, 1 tab, 32 ref.

Descriptors: *Aquatic animals, *Heavy metals, *Immunology, *Toxicity, *Water pollution effects, Cadmium, Copper, Crabs, Crustaceans, Cytology, Hemocytes, Mercury, Temperature effects.

The effects of heavy metals (20, 50, 500 and 1000 microgCu/L, 10 and 500 microgCd/L, and 5 and 50 microgHg/L) and temperature on the cellular (hemocyte) component of the immune system were investigated in the shore crab, Carcinus maenas (L.). Marked fluctuations in circulating hemocyte numbers were observed in control crabs; these appeared to correlate with daily changes in tidal height and the spring-neap tidal cycle. No change in hemocyte number was observed in crabs exposed to the metals for up to 30 days. However, Hg (Cu and Cd were not examined) at the highest

concentration used suppressed the tidal influence. A gradual rise in temperature from 10 to 20 C significantly increased blood cell numbers, although a rapid change initiated no response. In vitro cytotoxicity studies suggested that hemocytes were relatively tolerant of metals. Copper had no effect on recognition or phagocytosis of bacteria in vitro although Cd slightly suppressed phagocytosis. It is concluded that the immune system of C. maenas is relatively tolerant of metal stress. (Author's abstract)
W91-05049

EFFECTS OF CADMIUM ON ANOXIC SURVIVAL, HAEMATOLOGY, ERYTHROCYTIC VOLUME REGULATION AND HAEMOGLOBIN-OXYGEN AFFINITY IN THE MARINE BIVALVE SCAPHARCA INAEQUIVALVIS.
Aarhus Univ. (Denmark). Zoophysiology Lab.
R. E. Weber, M. Lykke-Madsen, A. Bang, A. De Zwaan, and P. Cortesi.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 144, No. 1, p 29-38, November 27, 1990. 4 fig, 1 tab, 31 ref. Commission of the European Communities 4th Research and Development Programme Contract EV4V-0121-DK, Danish Environmental Ministry Grant HAV-90/1-04, and Danish Natural Science Research Council Grant 11-7764.

Descriptors: *Animal physiology, *Aquatic animals, *Bivalves, *Cadmium, *Heavy metals, *Toxicology, *Water pollution effects, Anoxia, Erythrocytes, Hemoglobin, Mollusks.

Exposure to 50 ppb Cd for 6 weeks reduced survival of the bivalve, Scapharca inaequivalvis in anoxic water (LT50 decreasing approximately 15 to 12 days). The treatment decreased packed erythrocyte volume (hematocrit) and erythrocyte count but increased mean cellular hemoglobin concentration. In vitro cadmium administration had no significant effect on oxygen affinity or cooperativity in oxygen binding of the stripped hemolysate. Erythrocyte suspensions exhibited a slight volume regulatory decrease, following swelling in hypotonic media, and no significant capacity for volume regulatory increase under hypertonic stress. Neither pattern was markedly affected by in vivo or in vitro Cd administration, which however, tended to reduce the primary volume changes. It is concluded that the observed cellular and molecular effects of Cd are unlikely to have significant survival value in adult S. inaequivalvis since the pronounced ones (reduction in red cell count and hematocrit) are compensated by adaptive increases in hemoglobin(c). (Author's abstract)
W91-05052

EFFECTS OF MERCURY ON THE FUNCTIONAL PROPERTIES OF HAEMOGLOBINS FROM THE BIVALVE MOLLUSC SCAPHARCA INAEQUIVALVIS.
Aarhus Univ. (Denmark). Zoophysiology Lab.
R. E. Weber.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 144, No. 1, p 39-48, November 27, 1990. 6 fig, 22 ref. Commission of the European Communities 4th Research and Development Programme Contract EV4V-0121-DK, Danish Environmental Ministry Grant HAV-90/1-04, and Danish Natural Science Research Council Grant 11-7764.

Descriptors: *Animal physiology, *Aquatic animals, *Bivalves, *Heavy metals, *Mercury, *Toxicity, *Water pollution effects, Erythrocytes, Hemoglobin, Mollusks, Oxygen binding.

The effects of inorganic Hg were investigated on the functional properties of Scapharca inaequivalvis hemoglobin, which is endowed with a unique subunit assembly in that helices containing the Hg-binding cysteine residues are involved in the major intersubunit contact. Hg drastically increased oxygen affinity and depressed cooperativity of the stripped erythrolysate. Hg exerted a greater effect on the tetrameric HbII (2 alpha and 2 beta subunits) than on the homodimeric HbI (2 alpha subunits), the opposite of the relative affinities in metal-free preparations. The dose-response curves indicated a 1:1 stoichiometrical Hg:subunit binding with strong oxygenation linkage, and smaller effects at higher concentration ratios. In contrast, Cd, Cu, and Zn exerted only minor effects. It is concluded that a Hg-induced increase in oxygen affinity would facilitate oxygen loading under conditions of ambient oxygen depletion and simultaneously lower tensions for unloading oxygen in the metabolizing tissues. (Author's abstract)
W91-05053

IMPOSEX INDUCTION IN NUCELLA LIMA (GMELIN) VIA MODE OF EXPOSURE TO TRIBUTYLTIN.
Louisiana State Univ., Baton Rouge. Dept. of Zoology and Physiology.
W. B. Stickle, J. L. Sharp-Dahl, S. D. Rice, and J. W. Short.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 143, No. 3, p 165-180, November 13, 1990. 2 fig, 4 tab, 22 ref.

Descriptors: *Antifoulants, *Aquatic animals, *Bioaccumulation, *Bioindicators, *Organotin compounds, *Snails, *Toxicity, *Water pollution effects, Animal physiology, Foods, Imposex, Population exposure, Seawater.

Exposure of Nucella lima (Gmelin) to seawater or Mytilus trossulus (Gould) flesh containing tributyltin (TBT) for 4 months resulted in the development of imposex, the superimposition of male reproductive tract characteristics in female snails, in a time-dependent manner. Increases in the magnitude of two imposex indices, relative penis size (RPS) and the vas deferens sequence (VDS) index, were measured in female snails. Imposex characteristics developed to a similar degree in snails fed TBT-contaminated mussels (0.362 microg TBT/g wet weight) or exposed to 0.064 microg/L TBT in seawater by the second month of exposure. After exposure to TBT for 4 months, intensification of imposex characteristics continued during a 10-month recovery period. No significant differences in mortality and feeding rates occurred between control snails and those exposed to TBT-laden mussels or 0.064 microgTBT/L in seawater; significant mortality and a decreased feeding rate occurred in snails exposed to 0.914 microgTBT/L in seawater, indicating that this concentration is close to the long-term LC50. TBT was bioaccumulated from both food and seawater in direct relationship to concentration and length of exposure. Debutylization of TBT occurred at a slow rate in all experimental groups, but a higher proportion of TBT was metabolized in snails exposed to 0.914 microgTBT/L. For N. lima, TBT bioaccumulation from food and resulting imposex responses are equivalent to low level exposures to TBT in seawater. (Author's abstract)
W91-05054

EFFECTS OF ACIDIC SEAWATER ON THREE SPECIES OF LAMELLIBRANCH MOLLUSC.
National Power, Fawley (England). Marine Biology Unit.
R. N. Bamber.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 143, No. 3, p 181-191, November 13, 1990. 8 fig, 1 tab, 15 ref.

Descriptors: *Acidic water, *Mollusks, *Seawater, *Toxicity, *Water pollution effects, Acidic seawater, Hydrogen ion concentration, Lethal effects, Mussels, Oysters.

Three species of commercial bivalve mollusk, Ostrea edulis, Crassostrea gigas and Mytilus edulis, were maintained in seawater over a pH range of 5.4-8.2 (control), for 30 days. Significant mortalities occurred in C. gigas at pH < or = 6, in M. edulis at pH < or = to 6.6, in O. edulis young at pH < or = to 6.9 (after 60 days) and spat at at pH < or = to 7 after 18 days. Survival at a given pH level decreased with time of exposure and increased with temperature and size of animal. Growth suppression, tissue weight loss, reduced shell size, shell dissolution and suppressed feeding activity occurred at pH < or = 7. Abnormal behavior analogous to narcosis (excessive shell gaping, torpor) occurred at pH < or = to pH 6.5, possibly attributable to carbon dioxide excess. These and other collated results confirm that seawater at pH 7 or lower is intolerable to bivalve mollusks. (Author's abstract)
W91-05055

COMPREHENSIVE SURVEY OF THE HYPERTROPHIC LAKE TUUSULANJARVI: NUTRIENT LOADING, WATER QUALITY AND PROSPECTS OF RESTORATION.
Keski Uusimaa Inter-Municipal Corp. for Water Pollution Control, Kerava (Finland).
For primary bibliographic entry see Field 5G.
W91-05061

PALEOLIMNOLOGICAL INVESTIGATION OF THE EUTROPHICATION HISTORY OF LAKE TUUSULANJARVI, SOUTHERN FINLAND.
Joensuu Univ. (Finland). Dept. of Biology.
K. Tolonen, V. Ilmavirta, H. Hartikainen, and J. Suksi.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 27-41, 1990. 9 fig, 3 tab, 46 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Finland, *Lake Tuusulanjarvi, *Paleolimnology, *Water pollution effects, *Water pollution sources, Aeration, Agricultural runoff, Alkalinity, Diatoms, History, Hydrogen ion concentration, Lake restoration, Lake sediments, Palynology, Phosphorus, Radioactive dating, Sedimentation, Soil erosion, Wastewater pollution.

A 520-cm long sediment core was obtained from the deep of the highly eutrophic Lake Tuusulanjarvi (Finland), dated by 14C, 210Pb, and pollen analysis, and the eutrophication history of the lake was traced by sedimentary diatoms and chemistry. Originally the lake was pelotrophic, circumneutral, and more or less mesotrophic. Forest clearance and cultivation started in the lake catchment in about 1000 A.D. and resulted in a temporary slightly acidic and dystrophic stage. Field erosion and associated leaching of nutrients, as well as the effects of domestic wastewater from the growing urban and suburban population are reflected in the higher inferred pH and alkalinity figures from diatom assemblages (pH indexes, detrended correspondence analysis, and canonical correspondence analysis). Concurrently, the net sedimentation of total-P rose 10-fold and the concentration of the inorganic Fe-bound P fraction 6-fold above that of the precultivation stage. The mass sedimentation around the year 1980 rose to 7 kg/sq m/yr from 0.4 kg/sq m/yr during the precultivation period. These unusually high figures are, however, partly reflections of the strong sediment focusing in the narrow deep hollow of the lake. Recent limnological observations on the eutrophication of Lake Tuusulanjarvi agree with the paleolimnological records. The history of eutrophication resulting from sediments points to the need to maintain aeration as well as attempt to control external nutrient sources. The reduction of external non-point source load alone will not improve the lake significantly in the near future. (Author's abstract)
W91-05062

INTERACTIONS BETWEEN SHEWANELLA COLWELLIANA, OYSTER LARVAE, AND HYDROPHOBIC ORGANOPHOSPHATE PESTICIDES.
Maryland Univ., College Park. Marine-Estuarine-Environmental Sciences Program.
M. P. Labare, and R. M. Weiner.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 12, p 3817-3821, December 1990. 5 tab, 30 ref. Maryland Department of Natural Resources Grant S-124-88-088 and Maryland Sea Grant College Grant NA88-AAD-00014.

Descriptors: *Aquatic bacteria, *Biofilms, *Estuarine environment, *Oysters, *Pesticides, *Water pollution effects, Abate, Adsorption, Biological magnification, Malathion, Organophosphorus pesticides, Periphyton.

Shewanella colwelliana (strain D) is a periphytic estuarine bacterium that forms biofilms beneficial

to oyster set. The concentration by biofilms of two hydrophobic, organophosphate pesticides (Abate and malathion) that are detected in Chesapeake Bay oyster waters was examined. Both biofilms and purified exopolysaccharide of S. colwelliana did not adsorb more of the Abate or malathion than could be accounted for by adsorption to control surfaces. Similar results were obtained by using Deleya marina, Hyphomonas MHS3, and autochthonous biofilms. Conversely, decapsulated S. colwelliana D cells, prepared in the laboratory, bioconcentrated Abate. Significantly, the S. colwelliana D biofilms exposed to Abate did not inhibit the settlement and metamorphosis of Crassostrea gigas larvae. (Author's abstract)
W91-05096

CHRONIC TOXICITIES OF SURFACTANTS AND DETERGENT BUILDERS TO ALGAE: A REVIEW AND RISK ASSESSMENT.
Battelle, Columbus, OH. Environmental Biology and Assessment.
M. A. Lewis.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 123-140, October 1990. 1 fig, 2 tab, 101 ref.

Descriptors: *Algae, *Chronic toxicity, *Literature review, *Risk assessment, *Surfactants, *Toxicology, *Water pollution effects, Algal growth, Detergents, Ecosystems, Field tests, Marine environment, Structure-activity relationships.

The chronic toxicity levels of surfactants for algae, an important trophic level in aquatic ecosystems, are summarized. Laboratory toxicity tests for a few commercially important surfactants, primarily on cultured freshwater algae, have indicated inhibition, and in some cases, stimulation of algal growth. The reported toxicities of surfactants have varied widely over several orders of magnitude and the effect levels are compound and species-specific. Species sensitivity can vary as much as three orders of magnitude to the same surfactant and the effects of different surfactants on the same species can vary as much as four orders of magnitude. Therefore, data generalizations and extrapolations are difficult; however anionic and nonionic surfactants and detergent builders are relatively non-toxic when compared to various cationic monoalkyl and dialkyl quaternary ammonium salts. Recent toxicity studies conducted in the field monitoring the effects of several surfactants used in commercial products on various structural and functional parameters of natural algal communities have shown toxicity to be less in many cases than that predicted from laboratory tests. Furthermore, the field-derived effect levels typically exceed the reported measured environmental levels of the corresponding surfactant, indicating the likelihood of no impact. Additional field studies are needed to substantiate this trend for these and other commercially important surfactants, particularly for natural saltwater algal assemblages for which the toxicity data base is unavailable. (Author's abstract)
W91-05102

INFLUENCE OF CYTOCHROME P450 MIXED-FUNCTION OXIDASE INDUCTION ON THE ACUTE TOXICITY TO RAINBOW TROUT (SALMO GAIRDNERI) OF PRIMARY AROMATIC AMINES.
Environmental Research Lab., Duluth, MN.
J. L. M. Hermens, S. P. Bradbury, and S. J. Broderius.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 156-166, October 1990. 2 fig, 3 tab, 41 ref.

Descriptors: *Acute toxicity, *Amines, *Aromatic compounds, *Cytochromes, *Fish, *Toxicity, *Toxicology, *Water pollution effects, Aromatic amines, Dyes, Enzymes, Hydrocarbons, Lethal limit, Trout.

The influence of enzyme induction on the acute toxicity of aniline and 4-chloroaniline to rainbow trout (Salmo gairdneri) was investigated. For these two xenobiotics, bioactivation reactions are known to occur in mammals. Induction of cytochrome P450 mixed-function oxidase was obtained by intraperitoneal (ip) injection of trout with a mixture of polychlorinated biphenyls (Aroclor 1254). Five days after ip injection with three different doses of Aroclor 1254 (50, 100, and 200 mg/kg), benzo(a)pyrene hydroxylase activity in trout liver microsomes increased five-fold to six-fold. Cytochrome P450 concentrations in the microsomes were slightly but significantly enhanced in two of the three dose levels. The 96-h LC50's of aniline and 4-chloroaniline were not affected by pretreatment with Aroclor 1254, suggesting that metabolic activation does not necessarily play a role in the acute toxicity of aromatic amines to fish. (Author's abstract)
W91-05104

EVALUATION OF TOLUENE EXPOSURE VIA DRINKING WATER ON LEVELS OF REGIONAL BRAIN BIOGENIC MONOAMINES AND THEIR METABOLITES IN CD-1 MICE.
Utah State Univ., Logan. Dept. of Biology.
G. C. Hsieh, R. P. Sharma, R. D. R. Parker, and R. A. Coulombe.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 175-184, October 1990. 3 fig, 3 tab, 31 ref. U.S. Geological Survey Grant G-1255.

Descriptors: *Drinking water, *Population exposure, *Toluene, *Toxicity, *Water pollution effects, Brain biochemistry, Mice, Monoamines *Toxicology, Animal behavior, Dose-response relationships, Chronic toxicity.

Toluene, a potentially neurotoxic substance, is found in trace amounts in groundwater. Adult CD-1 mice were continuously fed drinking water ad libitum containing 0, 17, 80, and 405 mg/L toluene. After a 28-day treatment, animals were tested for endogenous levels of the biogenic monoamines norepinephrine (NE), dopamine (DA), and serotonin (5-HT) and their respective metabolites, 3-methoxy-4-hydroxymandelic acid (VMA), 3,4-dihydroxyphenylacetic acid (DOPAC), homovanillic acid (HVA), and 5-hydroxyindoleacetic acid (5-HIAA), in six discrete brain regions. The maximum toluene-induced increases of biogenic amines and their metabolites generally occurred at a toluene concentration of 80 mg/L. In the hypothalamus, a major NE-containing compartment, the concentrations of NE significantly increased by 51, 63, and 34% in groups dosed with 17, 80, and 405 mg/L, respectively. Significant increases of NE were also observed in the medulla oblongata and midbrain. Concomitantly, concentrations of VMA increased in various brain regions. Concentrations of DA were significantly higher in the corpus striatum and hypothalamus. Alterations in levels of DA metabolites, DOPAC and HVA, were marginal. Toluene significantly increased concentrations of 5-HT in all dissected brain regions, except cerebellum, and increased the 5-HIAA levels in the hypothalamus, corpus striatum, and cerebral cortex. The results support the possible involvement of monoamine metabolism in the reported behavioral and neurophysiological effects of toluene exposure. It is recommended that the EPA maximum permissible concentration for toluene (14.3 mg/L) be reevaluated. (Author's abstract)
W91-05106

BASELINE-ECOSYSTEM APPROACH TO THE ANALYSIS OF ECOTOXICOLOGICAL EFFECTS.
Bremen Univ. (Germany, F.R.). Fachbereich 2 - Studiengang Biologie.
K. Mathes, and G. Weidemann.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 197-202, October 1990. 4 fig, 17 ref. German Ministry of Research PTU: 0339238A.

Descriptors: *Bioindicators, *Ecology, *Ecosystems, *Ecotoxicology, *Environmental effects, *Toxicology, Data requirements, Environmental impact, Germany, Pesticides, Planning, Soil organisms.

Since 1980 the German Ministry of Research has sponsored a number of ecotoxicological research projects aimed at the analysis of effects of environmental chemicals on terrestrial ecosystems. Some of these field studies were conducted by using a baseline-ecosystem approach. The first step in the process is to detect and describe a chemically induced change by means of bioindicators. The next step is to judge what ecological consequences an observed change might have within the biogeocoenosis under study. The goal of the analysis is then possible: the valuation of the impact of a chemical on the biogeocoenosis. Criteria for the selection of bioindicators are considered: (1) spatial and temporal scales of exposition; (2) temporal variability of reaction and regeneration; and (3) taxonomic and biological diversity. An example of the operationalization of a ruderal biogeocoenosis as a baseline ecosystem includes plants as primary producers, soil animals such as enchytraeids, mites, and collembola as consumers, and microorganisms as reducers. The nitrogen cycle is studied as an integrative process which results from abiotic-biotic interactions within the biogeocoenosis. (MacKeen-PTT)
W91-05107

EMPLOYMENT OF CEPEX ENCLOSURES FOR MONITORING TOXICITY OF HG AND ZN ON IN SITU STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF ALGAL COMMUNITIES OF RIVER GANGA IN VARANASI, INDIA.
Banaras Hindu Univ., Varanasi (India). Centre for Advanced Study in Botany.
L. C. Rai, A. K. Singh, and N. Mallick.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 211-221, October 1990. 2 fig, 6 tab, 31 ref.

Descriptors: *Algae, *Heavy metals, *India, *Toxicity, *Toxicology, *Water pollution effects, Algal growth, Aquatic populations, Bioindicators, Carbon dioxide, Ganges River, Mercury, Nitrogen fixation, Zinc.

Effects of Hg and Zn on in situ nitrogen fixation, autotrophic index, pigment diversity, (C-14)carbon dioxide uptake, and change in algal community structure of Ganges water were studied for the first time in an aquatic ecosystem in India using Controlled Ecosystem Pollution Experiment (CEPEX) chambers. A concentration dependent decrease in in situ nitrogenase activity of Ganges water with Hg and Zn was observed. No ethylene production was observed at 0.8 microg/ml of Hg, however, an increase in the autotrophic index (AI) was observed in CEPEX enclosures treated with Hg and Zn. The AI value was maximum at 0.8 microg/ml Hg after an incubation of 15 d. An increase in pigment diversity also followed the pattern of AI with the test metals used. Inhibition of (C-14)carbon dioxide uptake of phytoplankton in Ganges water was maximum at 0.8 microg/ml Hg (79%), followed by 8.0 microg/ml Zn (69%). Carbon fixation showed an increase at 1 h, after which no appreciable change was observed. Maximum inhibition of algal number was observed at 0.8 microg/ml Hg, followed by 8.0 microg/ml Zn. Members of Chlorophyceae showed greater tolerance to the metals than did Cyanophyceae and Bacillariophyceae. The filamentous forms were more tolerant to Hg and Zn. In contrast, unicellular forms were more sensitive to Hg. The results suggest that (C-14)carbon dioxide fixation could be used as a sensitive parameter for metal toxicity biomonitoring. (Author's abstract)
W91-05108

FLUORIDE INDUCED CHANGES IN PROTEIN METABOLISM IN THE TISSUES OF FRESHWATER CRAB BARYTELPHUSA GUERINI.
Osmania Univ., Hyderabad (India). Dept. of Zoology.
S. L. N. Reddy, and N. B. R. K. Venugopal.
Environmental Pollution ENPOEK, Vol. 67, No. 2, p 97-108, 1990. 5 tab, 32 ref.

Descriptors: *Aquatic animals, *Crustaceans, *Fluorides, *Toxicity, *Toxicology, *Water pollution effects, Chronic toxicity, Crabs, Enzymes, Metabolism, Proteins, Sublethal effects.

Exposure of the freshwater field crab Barytelphusa guerini to a sublethal concentration of NaF (30 mg/L) caused significant alterations in protein metabolism. After an exposure time of 15 days, the crab was found to have a marked depletion of total protein and free amino acid content. The maximum reduction of total protein was found in the hepatopancreas (40.8%), followed by the gills (34.0%), muscle (25.9%) and heart (16.9%). A significant elevation in transaminases, aspartate aminotransferase and alanine aminotransferase, and glutamate dehydrogenase activities was reflected in the free amino acid levels of the tissues. Decreases in the protein content and the free amino acids during fluoride intoxication suggests an acceleration of protein catabolism as one of the possible physiological compensatory mechanisms under fluoride toxicity. (MacKeen-PTT)
W91-05109

INFLUENCE OF PERSISTENCE PERIOD OF AN INSECTICIDE ON RECOVERY PATTERNS OF A ZOOPLANKTON COMMUNITY IN EXPERIMENTAL PONDS.
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Hanazato, and M. Yasuno.
Environmental Pollution ENPOEK, Vol. 67, No. 2, p 109-122, 1990. 8 fig, 22 ref.

Descriptors: *Insecticides, *Pesticide toxicity, *Pesticides, *Succession, *Water pollution effects, *Zooplankton, Artificial ponds, Carbaryl, Cladocerans, Pesticide residues, Rotifers, Species composition.

An insecticide, carbaryl, was applied singly or repeatedly to experimental ponds in order to control the residue of the chemical, and the subsequent changes in the zooplankton community were investigated. In ponds where a single application of carbaryl, which degraded rapidly in the water, was made, cladocerans were reduced, but recovered soon and suppressed rotifers through competition. On the other hand, in ponds receiving repeated chemical applications, the treatment suppressed cladocerans for longer and induced the occurrence of abundant rotifers. The rotifer abundance after the treatment seemed to depend on the persistence period of the chemical. From these findings it can be hypothesized that applications of chemicals which have different degradation rates induce different zooplankton community structures. (Author's abstract)
W91-05110

PESTICIDE RESIDUES IN FRESHWATER AND MARINE ZOOPLANKTON: A REVIEW.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W91-05113

INFLUENCE OF DISSOLVED HUMIC MATERIALS ON THE BIOLOGICAL EFFECTS OF DRILLING COMPONENTS.
Mississippi Univ., University. Research Inst. of Pharmaceutical Sciences.
W. H. Benson, and R. A. Stackhouse.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 85-91, 4 tab, 36 ref.

Descriptors: *Bioaccumulation, *Drilling fluids, *Ecosystems, *Humic substances, *Toxicity, *Toxicology, *Water pollution effects, Bioassay, Cadmium, Chromium, Dissolved solids, Environmental impact, Groundwater pollution, Trace metals, Waterfleas.

Accurate prediction of the toxicity of trace metals associated with drilling fluids in the freshwater ecosystem is dependent on understanding the behavior of these elements in the environment. Dissolved humic materials (DHM) appear to have contradictory effects on the bioaccumulation of trace metals by marine and freshwater organisms. An investigation was made to evaluate the influence of DHM, humic acid (HA), on the toxicity and bioaccumulation of selected trace metals associated with drilling fluid components, cadmium and chromium. Due to their ecological significance, the cladocerans Daphnia pulex and D. magna were selected as animal models for acute toxicity bioassays, bioaccumulation analysis, and chemical analysis. it was found that HA had a greater influence on the bioaccumulation of Cd and the Cr III compounds than of Cr VI. The 50 mg/L HA concentration significantly decreased the bioaccumulation of Cd and both Cr III compounds (chromic chloride and chrome lignosulfate) at most of the time points, while only significantly decreasing bioaccumulation of Cr VI by 96 h. The interaction of trace metals and dissolved organic material, such as HA, can result in an altered physicochemical form of the metal, which in turn, may affect bioaccumulation. The results of this investigation indicate that the influence of HA on the bioaccumulation of Cr and Cd is dependent on oxidation state, temporal relationship, and HA concentration. (See also W91-05137) (Fish-PTT)
W91-05146

DEVELOPMENT OF A TOXIC ALEXANDRIUM MINUTUM HALIM (DINOPHYCEAE) BLOOM IN THE HARBOUR OF SANT CARLES DE LA RAPITA (EBRO DELTA, NORTHWESTERN MEDITERRANEAN).
Instituto de Ciencias del Mar, Barcelona (Spain).
M. Delgado, M. Estrada, J. Camp, J. V. Fernandez, and M. Santmarti.
Scientia Marina, Vol. 54, No. 1, p 1-7, March 1990. 7 fig, 26 ref.

Descriptors: *Mediterranean Sea, *Eutrophication, Sea mussels, *Dinoflagellates, *Toxicity, *Harbors, Sant Carles de la Rapita, *Path of pollutants, *Nutrients, *Shellfish, *Algal toxins, Mixing, *Red tides, Stratification, *Algal blooms, Phytoplankton, Human diseases, Sea mussels.

A bloom of Alexandrium minutum, reaching concentrations up to 2,800,000 cells/L, was observed in the harbor of Sant Carles de la Rapita (northwestern Mediterranean) on May 4, 1989. During the following days, paralytic shellfish poisoning toxicity was detected in mussels exposed to harbor waters and in mussels from the neighboring bay of Els Alfacs, where bivalves are extensively cultured. In El Fangar, the other bay of the delta, A. minutum was recorded in lower concentrations and no toxicity was detected in mussels. Shellfish harvesting was stopped in the delta region and no human illnesses occurred. During the initial stage of the red tide, the concentration of phytoplankton in the harbor was much higher than in the bay. Meteorological and hydrographic conditions during the red tide were typical of those reported for similar events. Mixing by strong winds may have caused nutrient enrichment, and the following warm weather and stratification of the water column then may have favored the accumulation of the phytoplankton. Continuing research is necessary to improve our understanding of red tide phenomena and to devise adequate forms of action to mitigate possible damages. (Brunone-PTT)
W91-05171

DIFFERENTIAL TOLERANCES AMONG SOFT-WATER MACROPHYTE SPECIES TO ACIDIFICATION.
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
G. H. P. Arts, J. G. M. Roelofs, and M. J. H. De Lyon.
Canadian Journal of Botany CJBOAW, Vol. 68, No. 10, p 2127-2134, 1990. 5 fig, 1 tab, 36 ref.

Descriptors: *Water pollution effects, *Acid rain effects, *Alkaline water, *The Netherlands, *Acidic water, *Acidification, *Macrophyte species, *Hydrogen ion concentration, Alkalinity, Distribution patterns, Historical data.

Twenty-six macrophyte species were studied for their degree of tolerance to extremely acid conditions. They are characteristic of soft water on sandy soils in The Netherlands. These species were divided into two groups based on their recent distribution by pH and alkalinity. The first group consisted of species that can (at least temporarily) survive under extremely acid conditions (pH < 5); the second group contained species that are limited by a distinct minimum pH of the water (pH 5-6). Disappearance of the two ecological groups of soft-water species from soft-water sites during acidification from 1937 to 1986 is shown graphically. In very soft waters, there was an early disappearance of the tolerant species. Where they coexisted, the less tolerant species generally disappeared before the tolerant species, a consequence of the reduction of alkalinity during acidification. This sharp distinction between groups on the basis of pH can be used for reconstruction of the development of acidification in waters using historical data on the macrophytes involved. The two groups of species can be used to discriminate between two types of soft water in The Netherlands. (Medina-PTT)
W91-05191

MICROBIOLOGY AND WATER CHEMISTRY OF TWO NATURAL SPRINGS IMPACTED BY GRAZING IN SOUTH CENTRAL NEVADA.
Nevada Univ., Las Vegas. Dept. of Biological Sciences.
D. A. Hall, and P. S. Amy.
Great Basin Naturalist GRBNAR, Vol. 50, No. 3, p 289-294, October 1990. 9 fig, 5 ref. Bureau of Land Management Contract UV053-R09-11.

Descriptors: *Water pollution effects, *Endangered species, *Cattle, *Fecal bacteria, *Water pollution sources, *Fish Conservation, *Feedlot runoff, Seasonal variation, Water level, Water temperature, Flow discharge, Hydrogen ion concentration, Dissolved oxygen, Conductivity, Bacterial analysis, Coliforms, Organic phosphorus, Pseudomonas, Aeromonas.

The water chemistry and microbial populations at two sites in southern Nevada: Ash Springs and Condor Canyon were monitored. Cattle impact was suspected to be a causative factor in increased mortality of two endangered fish species: White River springfish (Crenichthys baileyi baileyi) in Ash Springs and Big Springs spindace (Lepidomeda mollispinis pratensis) in Condor Canyon. Water samples were gathered and weather conditions, water levels and flow were monitored by observation. Water and air temperatures, conductivity, pH, and dissolved oxygen were tested in the field using calibrated equipment. Total bacterial counts were evaluated by dilution and spread plating as well as by membrane filtration during the winter months when the counts were low. Total coliforms were measured using the most probable number method and membrane filtration followed by growth on agar. Pseudomonas aeruginosa and Aeromonas hydrophila were also evaluated by membrane filtration. Although temperature in the Condor Canyon dropped during the winter months, it remained steady throughout the year in Ash Springs. Ammonia levels in the canyon fluctuated throughout the year, but a general increase was observed during December and January. A similar pattern was observed for nitrate plus nitrite and organic phosphorus levels. Total viable counts in the canyon were dramatically similar to organic phosphorus levels during March; also shown on microbial counts of P. aeruginosa and A. hydrophila, opportunistic fish pathogens. Elevated microbial levels during March were probably due to the availability of organic phosphorus and other nutrients washed in by the rain from both feces and any fertilizers used by the nearby rancher. As expected, bacterial levels were influenced by water temperatures, with higher counts correlating with warmer slower water and with times when cattle were more prevalent. (Medina-PTT)
W91-05204

DEGRADATION OF CHERNOZEMS ON THE DANUBE-DNIESTER IRRIGATION SYSTEM.
Odessa Agricultural Inst. (USSR).
For primary bibliographic entry see Field 3C.
W91-05227

EFFECT OF IRRIGATION WATERS POLLUTED WITH INDUSTRIAL WASTES ON HEAVY-METAL CONCENTRATION IN SOIL AND IN CERTAIN CROPS.
Erevan State Univ. (USSR).
For primary bibliographic entry see Field 5B.
W91-05235

HEALTH EFFECTS RESEARCH INITIATIVES AT THE AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY--APPLICABILITY TO CONTAMINATED SOILS.
Agency for Toxic Substances and Disease Registry, Atlanta, GA. Office of Health Assessment.
For primary bibliographic entry see Field 5E.
W91-05242

TOXICITY ASSESSMENT BY POLLUTION-INDUCED COMMUNITY TOLERANCE (PICT), AND IDENTIFICATION OF METABOLITES IN PERIPHYTON COMMUNITIES AFTER EXPOSURE TO 4,5,6-TRICHLOROGUAIACOL.
Goeteborg Univ. (Sweden). Dept. of Botany.
S. Molander, H. Blanck, and M. Soderstrom.
Aquatic Toxicology AQTODG, Vol. 18, No. 3, p 115-136, December 17, 1990. 5 fig, 6 tab, 37 ref.

Descriptors: *Toxicity, *Hazard assessment, *Chlorinated hydrocarbons, *Water pollution effects, *Periphyton, *Biotransformation, *Phenols, Metabolites, Sublethal effects, Population exposure, Bioassay, Bioindicators, Brackish water, Marine environment, Ecosystems, Trichloroguaiacol, Biomass, Species composition, Tolerance.

Periphyton communities established on artificial substrates in a brackish-water mesocosm test system and in a marine microcosm test system were exposed to 4,5,6-trichloroguaiacol (456-TCG; a polychlorinated phenolic compound) and monitored for effects on biomass, species composition and short-term tolerance of carbon dioxide incorporation. In the brackish-water mesocosms no effects on biomass or species composition were correlated with the 456-TCG exposures in the range of 1.7 to 50 nanomoles. The 20% effective concentration (EC20) of 456-TCG for short-term effects on periphyton CO2 incorporation were between 1 and 12 micromoles. Periphyton from the marine microcosm system showed the same short-term tolerance of CO2 incorporation except at the pre-exposure level of 32 micromoles, where a marked increase occurred. The pre-exposure of 32 micromoles is higher than the short-term EC20 of all periphyton communities exposed to lower pre-exposure concentrations. This is in accordance with the concept of Pollution Induced Community Tolerance (PICT) which states that a toxicant acting as a selection pressure on a community causes a tolerance increase due to exclusion of sensitive species and/or individuals from the community. The periphyton community exposed to 32 micromoles showed both an increased short-term tolerance, a decreased species number, and a decreased concentration of chlorophyll a. Two metabolites were identified in the periphyton of the microcosm test system, 3,4,5-trichlorocatechol (345-TCC) and 3-bromo-4,5,6-trichlorocatechol (BTCC). A dimeric biotransformation product was also found in the periphyton. Acid hydrolysis of both water and periphyton samples gave an increase in the amounts of 456-TCG and metabolites, indicating a large proportion of the compounds being bound or conjugated. (Author's abstract)
W91-05334

EFFECTS OF A PULP AND PAPER MILL EFFLUENT ON THE STRUCTURE AND METABOLISM OF PERIPHYTIC ALGAE IN EXPERIMENTAL STREAMS.
INRS-Eau, Sainte-Foy (Quebec).
C. Amblard, P. Couture, and G. Bourdier.
Aquatic Toxicology AQTODG, Vol. 18, No. 3, p 137-162, December 17, 1990. 9 fig, 5 tab, 62 ref.

Descriptors: *Eutrophication, *Pulp wastes, *Metabolism, *Algal growth, *Chlorophyta, *Water pollution effects, *Periphyton, *Effluents, *Toxicity, Wastewater analysis, Species diversity, Population density, Diatoms, Heterotrophic bacteria, Biomass, Autoradiography, Dissolved organic carbon, Photosynthesis.

The effects of a pulp and paper mill effluent on the structure and metabolism of periphytic algal communities were examined. The impact of pulp and paper mill effluent on periphytic algae growing under controlled conditions in experimental streams was manifested as a drop in species richness and diversity, and changes in the taxonomic structure of the algal community. The decrease in diatom density was compensated by the relative contribution of Chlorophyceae, which increased with increasing effluent concentration (0.5%, 2.5% and 10% vol/vol). The presence of effluent also led to a rise in heterotrophic biomass and activity. However, the stream with the highest effluent concentration (10% vol/vol) showed a greater autotrophic biomass, and had the lowest photosynthetic efficiency, suggesting that algal species which develop under such conditions exhibit important heterotrophic activity. This hypothesis was supported by micro-autoradiographic studies, which showed that Chlamydomonas cells were very strongly marked after incubation in the presence of amino acids, while diatoms showed little or no radioactivity. This suggested that the dissolved organic carbon in the effluent acted as a eutrophication factor for periphytic algal communities. (Author's abstract)
W91-05335

PHYSIOLOGICAL AND CELLULAR RESPONSES TO COPPER AND MERCURY IN THE GREEN MUSSEL PERNA VIRIDIS (LINNAEUS).
Central Marine Fisheries Research Inst., Cochin (India).
P. K. Krishnakumar, P. K. Asokan, and V. K. Pillai.
Aquatic Toxicology AQTODG, Vol. 18, No. 3, p 163-174, December 17, 1990. 2 fig, 2 tab, 42 ref.

Descriptors: *Toxicity, *Mussels, *Animal physiology, *Mercury, *Copper, *Water pollution effects, Marine environment, Sublethal effects, Path of pollutants, Bioassay, Tissue analysis, Animal tissues, Animal pathology, Heavy metals.

The suspension feeding bivalve mollusks accumulate and concentrate most pollutants within their tissues to concentrations significantly above ambient levels in the environment thus facilitating accurate chemical analysis and assessment. The physiological and cellular responses of Perna viridis after 1 and 2 weeks chronic exposure to copper (25 micrograms/L) and mercury (25 micrograms/L) was measured. Filtration rate, oxygen:nitrogen ratio, scope for growth and growth efficiency of metal exposed mussels decreased significantly in comparison to controls. Digestive cells and tissues of metal-exposed mussels had severe pathological changes such as increased lipofuscin accumulation, digestive tubule dilation, tubule breakdown and cilia loss in the digestive diverticula. Compared to mercury, copper accumulated more in the tissues of exposed mussels. The physiological and cellular responses of mussels to copper and mercury were generally in the same direction, although mercury exposed mussels were comparatively less affected. Toxic effects of copper and mercury observed at a cellular and tissue level were in agreement with those observed at the organismic level. (VerNooy-PTT)
W91-05336

SIMPLE BIOASSAY FOR THE DIAGNOSIS OF ALUMINIUM TOXICITY IN SOILS.
Queensland Dept. of Primary Industries, Indooroopilly (Australia). Agricultural Chemistry Branch.
For primary bibliographic entry see Field 5A.
W91-05340

EFFECTS OF LEACHING SURFACE-APPLIED AMENDMENTS ON SUBSOIL ALUMINUM AND ALFALFA GROWTH IN A LOUISIANA ULTISOL.
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W91-05341

SOLUBILITY AND HYDROLYSIS OF AQUEOUS ALUMINIUM HYDROXIDES IN DILUTE FRESH WATERS AT DIFFERENT TEMPERATURES.
Norges Landbrukshoegskole, Aas. Isotope Lab.
E. Lydersen.
Nordic Hydrology NOHYBB, Vol. 21, No. 3, p 195-204, 1990. 2 fig, 26 ref.

Descriptors: *Temperature effects, *Acid rain effects, Limnology, *Water chemistry, Inorganic compounds, *Hydrolysis, *Aluminum hydroxide, *Metal complexes, Water temperature, *Solubility, Dissolved solids, *Aluminum, Thermodynamics, Toxicity, Water quality, Aquifer systems.

Acidification of soil systems may cause a mobilization of toxic inorganic dissolved aluminum species from edaphic reservoirs to surface waters. The effect of temperature and pH on the chemistry of Al(OH)3(s) were studied using available thermodynamic data. Calculations show that a doubling of the concentration of H(+) or a decrease in temperature by 15 C, yields approximately the same solubility increase of the various Al(OH)3(s) presented. The relative concentration of aqueous aluminum hydrolysis complexes is also highly temperature-dependent. At decreased temperatures the concentration of Al(+3) greatly increases with respect to the other dissolved inorganic aluminum hydroxides. In natural soil/water systems the solubility products of crystalline and amorphous solid aluminum sources are unknown and the solubility may also be coupled to combined weathering/ion exchange processes. In addition, a substantial amount of aluminum may be present as organic complexes where aluminum by cation exchange reactions may enter the solution as monomeric inorganic species. Thus, if a low value for the equilibrium constants of Al(OH)3(s) is used as a reference when calculating the degree of aluminum saturation, an apparent oversaturation will often be demonstrated. Estimation of the degree of aluminum saturation in natural waters should therefore only be of theoretical interest. (Author's abstract)
W91-05383

EFFECT OF SIMULATED ACID RAIN ON QUANTITY OF EPIPHYTIC MICROFUNGI ON SCOTS PINE (PINUS SYLVESTRIS L.) NEEDLES.
Turku Univ. (Finland). Dept. of Biology.
H.M. Ranta.
Environmental Pollution ENPOEK, Vol. 67, No. 4, p 349-359, 1990.

Descriptors: *Acid rain, *Acid rain effects, *Fungi, *Pine trees, *Simulated rainfall, Artificial precipitation, Epiphytes, Finland, Species composition.

The effects of simulated acid rain on the phyllosphere microflora of pine were studied experimentally in northern Finland during the summer of 1988. Trees were irrigated with artificial acid rain of pH 4 and pH 3 (H2SO4 and HNO3, weight ratio of S:N = 2.86:1). Untreated trees and trees irrigated with spring water (pH 6) were used as controls. Two sampling heights (0.5 m and 2 m) were used. The needles were colonized exclusively by epiphytic fungi, mainly Aureobasidium pullulans (de Bary) Arnaud. The lower branches had significantly more epiphytic fungi than the upper branches. Compared to the control trees, the numbers of epiphytic fungi were significantly decreased on the needles of the trees irrigated with acid rain. Acid rain affected the number of epiphytic fungi equally at both sampling heights. The species composition of the epiphytic fungi was not affected by the acid treatments. (Author's abstract)
W91-05390

EFFECT OF LEAD, MERCURY AND CADMIUM ON A SULPHATE-REDUCING BACTERIUM.
National Inst. of Oceanography, Panaji (India).
P. A. Loka Bharthi, V. Sathe, and D.

Chandramohan.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 361-374, Oct-Dec 1990. 4 fig, 27 ref.

Descriptors: *Cadmium, *Lead, *Mercury, *Sulfur bacteria, *Toxicity, *Water pollution effects, Anaerobic bacteria, Bacterial growth, Culture media, Estuarine sediments, Heavy metals, India.

Heavy metals form an important class of pollutants but little is known about the effects of their accumulation on sediment microflora, such as the sulfate-reducing bacteria which play an important role in the anaerobic turnover of carbon and other elements in the environment. A marine bacterial strain, which resembles Desulfosarcina in its physiology, was isolated from off the south-west coast of India. This organism was tested for its behavior towards HgCl2, CdSO4, and Pb(NO3)2. The order of toxicity of these metal salts to growth in a lactate-based medium at 50 micrograms/ml concentrations was Cd>Pb>Hg and to respiration Pb>Cd>Hg. Inhibitory concentrations (viz. 100 micrograms/ml of HgCl2 and 200 micrograms/ml of Pb(NO3)2) had a stimulatory effect when the substrate was changed to acetate. With sodium acetate at 0.1% concentration, Hg and Pb had maximum stimulatory effect for growth and sulfide production. Experiments conducted directly with estuarine sediment slurries amended with lactate showed that all three metals (at levels below their inhibitory concentrations, i.e. 50 micrograms/ml of metal salt for Cd and Hg and 100 micrograms/ml for Pb) inhibited sulfide-reducing activity (SRA) with Pb decreasing the peak production by 68%. The order of toxicity in both lactate and acetate-amended slurry was Pb>Cd>Hg and Pb>Hg>Cd, respectively. With acetate, SRA in the presence of Cd and Hg was stimulated 110% and 27% respectively. Pb inhibited SRA by 11%. There was a general reduction in the inhibition of sulfide production in slurries as compared with pure culture of the isolate. (Author's abstract)
W91-05391

LONG-TERM SWINE LAGOON EFFLUENT APPLICATIONS ON 'COASTAL' BERMUDAGRASS: II. EFFECT ON NUTRIENT ACCUMULATION IN SOIL.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
For primary bibliographic entry see Field 5E.
W91-05406

ICHTHYOFAUNAL EVALUATION OF THE PEACE RIVER, FLORIDA.
Florida Game and Fresh Water Fish Commission, Lakeland, FL.
T. R. Champeau.
Florida Scientist FLSCAQ, Vol. 53, No. 4, p 302-311, Autumn 1990. 1 fig, 2 tab, 26 ref.

Descriptors: *Fish populations, *Florida, *Peace River, *Species composition, *Species diversity, *Water pollution effects, Biological oxygen demand, Biomass, Ecological effects, Environmental effects, Population dynamics, Turbidity.

Fishes were collected from six locations along the freshwater portion of the Peace River from 1983 through 1988. Analysis of fish community characteristics such as species richness, diversity, abundance, biomass and species composition indicated the fish community of the Peace River has been significantly impacted by human activities. Degraded water quality and invasion of exotic fishes have altered species composition, diversity and fish production. Effluent from headwater lakes and streams increased turbidity and biological oxygen demand in the upper 35-km section of the river that was dominated by pollution-tolerant fishes. Dilution from tributaries exhibiting higher water quality improved biotic conditions downstream as evidenced by higher species diversity and more complex fish community structure. Tidal influence on the lower 35-km portion of the river reduced flushing and stressed conditions were indicated by lower species richness and diversity. Fish community structure at the lower river was dominated by large piscivores and omnivores. (Author's abstract)
W91-05411

MOBILIZATION OF COLLOIDS IN GROUNDWATER DUE TO INFILTRATION OF WATER AT A COAL ASH DISPOSAL SITE.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
P. M. Gschwend, D. A. Backhus, J. K. MacFarlane, and A. L. Page.
Journal of Contaminant Hydrology JCOHE6, Vol. 6, No. 4, p 307-320, December 1990. 5 fig, 3 tab, 18 ref.

Descriptors: *Ash disposal, *Coal ash, *Colloids, *Groundwater pollution, *Leaching, *Path of pollutants, *Water pollution effects, *Water pollution sources, Carbonates, Electric powerplants, Groundwater movement, Infiltration, Pollution load, Sampling, Silicates, Suspended solids.

Groundwaters in the vicinity of a coal ash site near an electric generating station in the western U.S.A. were studied to ascertain why fine particles or colloids appear in local groundwater samples. Application of very careful sampling techniques (slow pumping rates, no atmospheric exposure) did not cause the large quantities of colloids observed previously to disappear from well water in which they occurred. The same sampling procedures did not cause similar abundances of colloids to appear in waters collected from neighboring wells installed and developed in the same manner and in the same geologic strata. Groundwater chemistry and the nature of the suspended colloids (size, composition) strongly suggest these fine particles were suspended and therefore moving with the groundwater flow. At wells exhibiting large amounts of suspended colloids (approximately 10-100 mg/L), the water was enriched in carbon dioxide and depleted in oxygen relative to nearby locations. The colloids were typically between 0.1 and 2 microns in size and were primarily silicates. These results suggest that, where infiltrating water is percolating through a site that has been mixed with coal ash, the secondary carbonate minerals in the soils are being dissolved; removal of this cementing carbonate phase may consequently release soil silicate colloids to be carried in the flowing water. Such processes may enhance contaminant transport in groundwater by augmenting the pollutant load moving in the groundwater, and increasing the permeability of the porous medium to pollutant infiltration with waste water and/or rainwater. (Author's abstract)
W91-05413

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: LONG-TERM RECONSTRUCTIONS AT TWO SITES IN CENTRAL SCOTLAND.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
B. J. Cosby, A. Jenkins, R. C. Ferrier, J. D. Miller, and T. A. B. Walker.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 143-162, December 1990. 7 fig, 6 tab, 41 ref.

Descriptors: *Acid rain, *Acidic water, *Acidification, *Environmental effects, *Forest management, *Forest watersheds, *Forests, *Model studies, *Scotland, *Water pollution effects, Acid streams, Air pollution, Environmental chemistry, Evapotranspiration, Forestry, Path of pollutants, Soil chemistry.

A conceptual model of the combined effects of afforestation and acidic deposition was applied to two forested sites in central Scotland. Refinements were made to the model inputs specifically to include: increased dry deposition to the forests (in excess of the dry deposition expected for moorland sites) as the forest canopy develops; uptake of ions by the growing forests; and increased evapotranspiration (and thus decreased water yield) as the forests mature. The model was calibrated using a fuzzy optimization technique which incorporated uncertainty in target variables (stream base cation concentrations and soil exchangeable bases) and uncertainty in selecting values for fixed and adjustable parameters which describe the physicochemical characteristics of the catchments. Simulated present-day stream and soil chemistry closely matched observed values at both sites. The calibrated models indicated that while the patterns of acidification in the two catchments are broadly similar, some differences do exist between the sites in the response of the soils to acidic deposition and afforestation. It was concluded that the calibrated models provide a tool for: (1) comparison of the relative effects of deposition and afforestation on soil and surface water acidification; and (2) assessment of the likely effects of reductions in future deposition combined with future forestry management practices. (See also W91-05437) (Author's abstract)
W91-05436

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: AN ASSESSMENT OF THE RELATIVE EFFECTS OF ACID DEPOSITION AND AFFORESTATION.
Institute of Hydrology, Wallingford (England).
A. Jenkins, B. J. Cosby, R. C. Ferrier, T. A. B. Walker, and J. D. Miller.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 163-181, December 1990. 6 fig, 3 tab, 25 ref.

Descriptors: *Acid rain, *Acid streams, *Acidification, *Environmental effects, *Forest management, *Forest watersheds, *Forestry, *Path of pollutants, *Scotland, *Water pollution effects, Air pollution, Model studies, Soil chemistry.

A model of the combined long-term effects of acidic deposition and forest growth was developed and calibrated for un upland site in Scotland. The model was used to perform a series of simulation experiments to assess the relative effects of afforestation and acidic deposition on soil and surface water chemistry. The experiments compare and contrast: (1) the simulated historical effects of increased acidic deposition and forest growth, both individually and in combination; and (2) the simulated future effects of various levels of reduction of deposition in combination with the forestry strategies of harvesting with and without replanting. Results indicate that historical acidification of surface waters in areas receiving high levels of acidic deposition has been exacerbated by afforestation practices. Afforestation in the absence of acidic deposition, however, has had a lesser effect on surface water acidification even though the nutrient demands of forest growth have caused significant soil acidification. Comparisons of future forest management strategies in conjunction with likely deposition reductions indicate that, in sensitive areas, replanting of a felled forest without treatment of the soil by addition of base cations, should not be undertaken even if significant deposition reductions are realized. (See also W91-05436) (Author's abstract)
W91-05437

BIOACCUMULATION OF MUTAGENS AND PROMUTAGENS IN FISH TAKEN FROM FOUR SITES IN NORTHEAST TENNESSEE.
East Tennessee State Univ., Johnson City. Dept. of Health Sciences.
For primary bibliographic entry see Field 5A.
W91-05462

CHANGES OF OXYGEN CONSUMPTION ON PROCAMBARUS CLARKII EXPOSED TO METHIDATHION: EFFECT ON ISOLATED GILLS.
Valencia Univ. (Spain). Dept. of Animal Physiology.
C. Cebrian, E. Andreu-Moliner, A. Fernandez-Casalderrey, and M. D. Ferrando.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 6, p 767-775, 1990. 3 fig, 1 tab, 22 ref.

Descriptors: *Crayfish, *Insecticides, *Laboratory methods, *Methidathion, *Organophosphorus pesticides, *Oxygen requirements, *Pesticides, *Water pollution effects, Animal physiology, Contamination, Environmental effects, Gills, Respiration, Solvents, Synergistic effects.

The effects of exposure to methidathion, an organophosphate insecticide, on the gill respiration rate of Procambarus clarkii were determined by using a

Gilson differential respirometer. Procambarus clarkii was exposed to LC50-96h, 1/5 LC50-96h and 1/10 LC50-96h for 0, 24, 48, 72, and 96 h. Only the LC50 value, measured after 96 h, significantly increased the oxygen consumption rate ($p < 0.05$). The solvent, ethanol, caused a synergistic decrease in oxygen consumption with the methidathion. Although laboratory exposure to one contaminant cannot account for all natural conditions because toxicity is influenced by many natural factors, any factor may become a limiting factor to the crayfish in a grossly polluted natural environment. However, the results of a controlled exposure experiment may prove useful in understanding the nature and action of this pesticide. (Brunone-PTT)
W91-05467

TOXICITY OF CHROMIUM (VI) TO PHOTOSYNTHESIS OF THE PHYTOPLANKTON ASSEMBLAGE OF LAKE ERIE AND THE DIATOM FRAGILARIA CROTONENSIS KITTON.
Windsor Univ. (Ontario). Dept. of Biology.
D. G. Wallen.
Aquatic Botany AQBODS, Vol. 38, No. 4, p 331-340, December 1990. 2 fig, 3 tab, 32 ref.

Descriptors: *Algae, *Chromium, *Diatoms, *Fragilaria, *Heavy metals, *Lake Erie, *Lakes, *Photosynthesis, *Phytoplankton, *Toxicity, *Water pollution effects, Analytical methods, Inhibition, Irradiation.

The toxicity of chromium to the photosynthesis of algae, specifically the diatom Fragilaria crotonensis Kitton, and natural phytoplankton assemblages in Lake Erie was investigated. Photosynthesis was measured in the presence of chromium (VI) at concentrations from 0 to 2.0 micromolar. All chromium (VI) concentrations tested inhibited the photosynthetic capacity (Pmax) of the photosynthetic-irradiance (P-I) relationship of F. crotonensis, with inhibition being greatest at 2.0 micromolar Cr(VI), the highest concentration tested. Pmax values of the phytoplankton assemblage were also reduced, but the effects were less severe in that 2.0 micromolar Cr(VI) reduced Pmax to 37.5% of the control compared with 5.9% for F. crotonensis. Changes in the slope of the P-I curve of F. crotonensis indicated inhibition at all concentrations except 0.5 micromolar Cr(VI), with inhibition being greatest at 2.0 micromolar Cr(VI), 12.4% of the control. However, for the phytoplankton assemblage, inhibition was observed only at a concentration of 2.0 micromolar. (Author's abstract)
W91-05486

ELECTROPHILES AND ACUTE TOXICITY TO FISH.
Utrecht Rijksuniversiteit (Netherlands). Research Inst. of Toxicology.
J. L. M. Hermens.
Environmental Health Perspectives EVHPAZ, Vol. 87, p 219-225, July 1990. 4 tab, 32 ref.

Descriptors: *Electrophiles, *Water pollution effects, *Fish, *Toxicity, *Chemical reactions, Lethal limit, Organic compounds, Hydrophobic compounds, Ecotoxicology, Chemical properties, Mutagens.

Electrophiles are a class of compounds that can react with several types of nucleophiles. Amino (-NH2), hydroy (-OH), and sulfhydryl (-SH) groups are the most important of these from a biological point of view because they are found in many biological macromolecules, such as in proteins and in organic bases in DNA. Effect concentrations in fish LC50 tests with directly acting electrophiles are lower than those of unreactive chemicals that act by narcosis. LC50 values of more hydrophobic reactive chemicals tend to approach those of unreactive chemicals. Quantitative studies to correlate fish LC50 data to physical-chemical properties indicate that LC50 values of reactive chemicals depend on hydrophobicity as well as chemical reactivity. Several examples are given of reactive chemical substructures according to the atom or chemical group that can bind a nucleophile: acylation reaction, reaction with cyanate, reaction with carbonyl compounds, alkylation and arylation reactions, reaction with metal ions and organometallic compounds, and other miscellaneous reactions with sulfhydryl groups. This classification might be useful to identify chemicals that are more effective at lower concentrations than unreactive compounds. Chemicals that require bioactivation are not included because almost no information is available on the influence of bioactivation on acute toxic effects in aquatic organisms. (Lantz-PTT)
W91-05566

COPPER TOXICITY TO MICROSCOPIC STAGES OF GIANT KELP MACROCYSTIS PYRIFERA: INTERPOPULATION COMPARISONS AND TEMPORAL VARIABILITY.
California Univ., Santa Cruz. Inst. of Marine Sciences.
B. S. Anderson, J. W. Hunt, S. L. Turpen, A. R. Coulon, and M. Martin.
Marine Ecology Progress Series MESEDT, Vol. 68, No. 1/2, p 147-156, December 15, 1990. 4 fig, 44 ref. CSWRCB Contract No. 7-120-250-0.

Descriptors: *Algal growth, *Copper, *Kelps, *Toxicity, *Water pollution effects, Germination, Laboratory methods, Lethal limit, Spores, Temporal variation.

Experiments were conducted to evaluate temporal and geographic variation in sensitivity of microscopic stages of giant kelp Macrocystis pyrifera to copper. Spores from kelp sporophylls collected from different locations and at different times of the year were exposed to series of copper concentrations following a standard toxicity test procedure. After 48 h static exposures, toxicity was determined by measuring 2 test endpoints: germination success and growth of germination tubes. The sensitivity of these endpoints to copper was also compared with the sensitivity of longer-term reproductive endpoints: sporophyte production and sporophyte growth. No significant differences in response to copper were found among spores from collection sites. Variability between 4 tests conducted quarterly throughout the year was greater than that between 3 tests done consecutively within 1 month, indicating temporal variability in response to copper. Long-term reproductive endpoints were more sensitive to copper than were short-term vegetative endpoints, with no observed effects concentration of < 10 microg/L for sporophyte production, 10 microg/L for sporophyte growth, 10 microg/L for germ-tube growth, and 50 microg/L for germination inhibition. (Author's abstract)
W91-05592

FATE OF MEVINPHOS SPILL AND WATER QUALITY: A CASE STUDY FROM LAKES PEN MUNICIPAL DUMP.
Underground Water Authority, Kingston (Jamaica).
For primary bibliographic entry see Field 5B.
W91-05659

DETECTION AND CHARACTERIZATION OF (3H)2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN BINDING TO AH RECEPTOR IN A RAINBOW TROUT HEPATOMA CELL LINE.
Hospital for Sick Children, Toronto (Ontario). Div. of Clinical Pharmacology and Toxicology.
A. Lorenzen, and A. B. Okey.
Toxicology and Applied Pharmacology TXAPA9, Vol. 106, No. 1, p 53-62, October 1990. 8 fig, 31 ref.

Descriptors: *Dioxins, *Laboratory methods, *Pollutant identification, *Water pollution effects, Aromatic compounds, Bioaccumulation, Hazardous materials, Hydrocarbons, Oil, Receptors, Tissue analysis, Trout.

Several species of teleost fish are highly sensitive to halogenated aromatic hydrocarbons, such as 'dioxins' and polychlorinated biphenyls, as well as non-halogenated aromatic hydrocarbons and crude petroleum mixtures. Although the toxicity to fish is well-recognized, virtually nothing is known about how fish recognize and respond to toxic aromatics. Aromatic hydrocarbon (Ah) receptor was identified and characterized in cytosol and nuclear extracts from the rainbow trout hepatoma cell line RTH-149. The cytosolic receptor was detectable with both halogenated ((3H)2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)) and non-halogenated ((3H)3-methylcholanthrene and ((3H)benzo(a)pyrene aromatic hydrocarbons and sedimented at approximately 9 S after velocity sedimentation on sucrose gradients. The apparent binding affinity of cytosolic Ah receptor was always less than 1 nanomolar as derived from Scatchard or Woolf plot analyses. The same analyses indicated a concentration of Ah receptor in the RTH-149 cells of approx 20 femtomole/mg cytosolic protein or approximately 4400 receptor sites per cell. Thus, this trout hepatoma cell line has a low concentration of high-affinity binding sites compared to cytosol obtained from rodent tissues. Incubation of whole cells with the radioligand (3H)TCDD resulted in transformation of the cytosolic Ah receptor to a nuclear binding form that could be detected as a specifically labeled peak sedimenting at approximately 6 S on sucrose gradients. Aryl hydrocarbon hydroxylase was induced after exposure of RTH-149 cells to TCDD or benz(a)anthracene for 24 hr in culture. These data demonstrate the existence of the Ah receptor in a cell line derived from a nonmammalian species and provide an additional step toward understanding the mechanisms by which fish respond to specific aquatic contaminants. (Author's abstract)
W91-05830

ELECTROPHILES AND ACUTE TOXICITY TO FISH.
Utrecht Rijksuniversiteit (Netherlands). Research Inst. of Toxicology.
J. L. M. Hermens.
Environmental Health Perspectives EVHPAZ, Vol. 87, p 219-225, July 1990. 4 tab, 32 ref.

Descriptors: *Water chemistry, *Toxicology, *Electrophiles, *Fish, *Toxicity, *Water pollution effects, *Ecotoxicology, Chemical properties, Hydrophobic compounds, Lethal limit, Mutagens, Organic compounds, Chemical reactions.

Electrophiles are a class of compounds that can react with several types of nucleophiles. Amino (-NH2), hydroy (-OH), and sulfhydryl (-SH) groups are the most important of these from a biological point of view because they are found in many biological macromolecules, such as in proteins and in organic bases in DNA. Effect concentrations in fish LC50 tests with directly acting electrophiles are lower than those of unreactive chemicals that act by narcosis. LC50 values of more hydrophobic reactive chemicals tend to approach those of unreactive chemicals. Quantitative studies to correlate fish LC50 data to physical-chemical properties indicate that LC50 values of reactive chemicals depend on hydrophobicity as well as chemical reactivity. Several examples are given of reactive chemical substructures according to the atom or chemical group that can bind a nucleophile: acylation reaction, reaction with cyanate, reaction with carbonyl compounds, alkylation and arylation reactions, reaction with metal ions and organometallic compounds, and other miscellaneous reactions with sulfhydryl groups. This classification might be useful to identify chemicals that are more effective at lower concentrations than unreactive compounds. Chemicals that require bioactivation are not included because almost no information is available on the influence of bioactivation on acute toxic effects in aquatic organisms. (Lantz-PTT)
W91-05891

SOLUBLE METALS IN THE ATMOSPHERE AND THEIR BIOLOGICAL IMPLICATIONS: A STUDY TO IDENTIFY IMPORTANT AEROSOL COMPONENTS BY STATISTICAL ANALYSIS OF PIXE DATA.
Florida State Univ., Tallahassee. Dept. of Oceanography.
J. W. Winchester.
Biological Trace Element Research BTERDG, Vol. 26/2, p 195/212, December 1990, 2 fig, 3 tab, 39 ref.

Descriptors: *Acid rain effects, *Aerosols, *Air pollution, *Air pollution effects, *Atmospheric chemistry, *Statistical analysis, *Trace metals, Aluminum, Atmospheric deposition, Chemical analysis, Ecological effects, Human diseases, Iron, Multivariate analysis, Solubility, Sulfur dioxide, Trace elements, X-ray spectroscopy.

Multivariate statistical analysis has been applied to time series measurements of aerosol elemental composition from PIXE (photon-induced x-ray emission) analysis of filter samples, and principal components have been resolved that represent distinct particle types in an external mixture in the atmosphere. A combination of chemical and statistical analyses of the data may be more powerful in determining chemical species in atmospheric aerosols than studies that employ mainly direct chemical analysis of chemical species in unresolved mixtures of aerosol particle samples. Sulfur is generally associated with mineral dust elements. It is reasoned that the association may represent sulfuric acid coatings on particles that can lead to mineral dissolution and solubilization of significant amounts of aluminum, iron, and other metals. Upon wet or dry deposition to the surface, the fluxes of these metals in biologically-available form may be sufficient to affect primary productivity in the world ocean and cause ecological damage in lakes. As a consequence, the fluxes of biogenic trace gases to the atmosphere may be changed, possibly leading to changes in the tropospheric concentration of ozone. The inputs to lakes of soluble aluminum, which is toxic to fish, may be partly by deposition directly from the atmosphere , thus not limited to leaching of soils by acid deposition. Human inhalation of soluble aluminum and other solubilized mineral metals may account, in part, for the observed geographic pattern of deaths attributed to chronic obstructive pulmonary disease (COPD) that show high rates in cities of the Western US and southeast region, but low in most of the midwest and northeast. (Author's abstract)
W91-05894

STUDIES OF CADMIUM UPTAKE IN BONE AND ITS ENVIRONMENTAL DISTRIBUTION.
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
For primary bibliographic entry see Field 5B.
W91-05895

QUESTION OF NITRATES.
Salford Univ. (England). Environmental Resources Unit.
For primary bibliographic entry see Field 5B.
W91-05904

MICRONUCLEUS TEST IN FISH FOR MONITORING THE GENOTOXIC EFFECTS OF INDUSTRIAL WASTE PRODUCTS IN THE BALTIC SEA, SWEDEN.
Institut Jozef Stefan, Ljubljana (Yugoslavia).
For primary bibliographic entry see Field 5A.
W91-05944

ALASKA'S RESPONSE TO THE EXXON VALDEZ OIL SPILL.
Alaska State Dept. of Environmental Conservation, Juneau.
For primary bibliographic entry see Field 5G.
W91-05946

EXXON VALDEZ OIL SPILL: INITIAL ENVIRONMENTAL IMPACT ASSESSMENT.
Exxon Co. USA, Anchorage, AK.
A. W. Maki.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 24-29, January 1991. 5 fig, 1 tab, 12 ref.

Descriptors: *Alaska, *Cleanup operations, *Environmental impact, *Exxon Valdez, *Oil spills, *Water pollution effects, Fisheries, Monitoring, Oil pollution, Oil recovery, Prince William Sound, Toxicity, Wildlife.

Exxon's response to the Exxon Valdez oil spill on Bligh Reef in Prince William Sound in Alaska was unprecedented in scale. The Exxon response included the employment of more than 11,000 people, utilization of essentially the entire world supply of containment booms and skimmers, and an expenditure of more than two billion dollars. Following the spill and cleanup, Exxon mobilized a massive environmental assessment program. Data from these studies indicate that wildlife and habitats are recovering from the impacts of the spill and that commercial catches of herring and salmon in Prince William Sound are at record high levels. Samplings of petroleum aromatic hydrocarbons concentrations in the waters clearly demonstrate that average levels have remained well below exposure levels known to cause acute and chronic effects to sensitive aquatic life. Field counts of plants, fish and mammals from throughout the spill area provide convincing data that wildlife species are surviving and reproducing, thus confirming that biological recovery is rapidly taking place. Ecosystem recovery from spill impacts is due to the combined efforts of the cleanup program as well as natural physical, chemical, and biological processes. From all indications this recovery process can be expected to continue. (See also W91-05946) (White-Reimer-PTT)
W91-05947

5D. Waste Treatment Processes

DYNAMICS AND CONTROL OF SUBSTRATE INHIBITION IN ACTIVATED SLUDGE.
Waterloo Univ. (Ontario). Dept. of Chemical Engineering.
P. J. Allsop, M. Moo-Young, and G. R. Sullivan.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 20, No. 2, p 115-167, 1990. 8 fig, 2 tab, 265 ref.

Descriptors: *Activated sludge, *Activated sludge process, *Biological wastewater treatment, *Control systems, *Industrial wastewater, *Wastewater treatment, Chemical industry, Kinetics, Literature review, Phenols, Steel industry.

The activated sludge wastewater treatment process predominantly used in the chemical and steel industries was reviewed to determine the dynamics and control of activated sludge systems treating inhibitory wastes. While this process has the capacity to degrade a variety of toxic or inhibitory wastes, the underlying mechanisms are not clear. A variety of issues exist requiring further study: (1) the role of various microorganisms in waste removal and system stability, (2) the mechanisms of inhibitory action at both the level of the primary consumer and at the level of the whole process, (3) the suitability of phenol as a model inhibitory substrate, (4) the appropriateness of using pure culture, CSTR results obtained at relatively high specific growth rates to predict the response of activated sludge systems, (5) the rationalization of microbiological predictions for oligotrophic systems with observations in activated sludge systems, and (6) the development of appropriate monitoring tools for detecting process instabilities. (Feder-PTT)
W91-04937

BACTERIAL LEACHING OF HEAVY METALS FROM SEWAGE SLUDGE-BIOREACTORS COMPARISON.
INRS-Eau, Sainte-Foy (Quebec).
D. Couillard, and G. Mercier.
Environmental Pollution ENPOEK, Vol. 66, No. 3, p 237-252, 1990. 4 fig, 5 tab, 29 ref.

Descriptors: *Aeration, *Biological treatment, *Cadmium, *Copper, *Heavy metals, *Leaching, *Municipal wastes, *Sewage bacteria, *Sludge treatment, *Wastewater treatment, *Zinc, Hydrogen ion concentration, Land disposal, Retention time.

Microbial leaching of heavy metals from municipal sludge was studied in a continuously stirred tank reactor without recycling (CSTR) or with sludge recycling (CSTRWR) at residence times of 1,2,3 and 4 days. The CSTRWR and the CSTR with a 1 g/L FeSO4.7H20 addition were equally efficient because of copper reprecipitation or recomplexation in the settling tank of the CSTRWR. In the CSTR, about 62% of copper and about 77% of zinc were dissolved in three days residence time compared to 50% of copper and 64% of zinc in the CSTRWR if 3 g/L FeSO4 was added. Thus with a larger amount of substrate the CSTR was more efficient than the CSTRWR. Residence time and pH were the main factors for zinc solubilization while for copper, the redox potential was also a major factor. Increased concentration of FeSO4.7H2O yielded better copper solubilization while it had no effect or a negative effect on zinc. (Author's abstract)
W91-04943

BEHAVIOR OF CARBON MONOXIDE AS A TRACE COMPONENT OF ANAEROBIC DIGESTER GASES AND METHANOGENESIS FROM ACETATE.
Michigan Biotechnology Inst., Lansing.
R. F. Hickey, and M. S. Switzenbaum.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1642-1648, November 1990. 4 fig, 3 tab, 45 ref.

Descriptors: *Acetates, *Anaerobic digestion, *Biodegradation, *Carbon monoxide, *Methanogenesis, *Sludge digestion, *Wastewater treatment, Thermodynamics.

The levels of gaseous carbon monoxide in anaerobic digester samples and digester inocula in defined media are directly related to the acetate concentrations and inversely related to methane concentrations. This thermodynamic framework better explains acetate metabolism by methanogens from a redox perspective. The carbon monoxide concentration increased in response to perturbing the digestion process by increasing organic loading or adding acetate. Reducing headspace methane level resulted in higher measured carbon monoxide concentrations. A thermodynamic relationship was developed by dividing the acetoclastic methane reaction into two half-cell reactions, representing production of and subsequent oxidation of carbon monoxide. A constant fraction for the total free energy available for acetate conversion to methane was assigned to each half-cell based on experimental observations. It was determined that approximately 54% of the energy available for acetate conversion to methane was consistently associated with the anaerobic oxidation of carbon monoxide to carbon dioxide. Estimated values compared well for measured concentrations for both mesophilic and thermophillic digesters operating under steady-state conditions. The thermodynamic relationship, based upon gaseous components only, was manipulated to accurately predict acetate concentration in a digester system subjected to an organic overload that was monitored with an on-line data acquisition system. (Author's abstract)
W91-04944

STOICHIOMETRY AND KINETICS OF THE REACTION OF NITRITE WITH FREE CHLORINE IN AQUEOUS SOLUTIONS.
California Univ., Berkeley. Dept. of Civil Engineering.
V. Diyamandoglu, B. J. Marinas, and R. E. Selleck.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1711-1718, November 1990. 9 fig, 3 tab, 16 ref.

Descriptors: *Chlorides, *Chlorination, *Chlorine, *Disinfection, *Nitrates, *Nitrites, *Wastewater treatment, *Water treatment, Hydrogen ion concentration, Kinetics.

The reaction of nitrite with free chlorine in dilute aqueous solution ($3.4 < pH < 11.5$) was studied under continuous-flow mixing conditions. Chlorine, chloride, nitrite and nitrate were all measured analytically. Stoichiometric balances demonstrated that nitrite was oxidized to nitrate and chlorine was reduced to chloride, without the significant production of any other chemical species. The kinetic studies demonstrate that the reaction is very fast at neutral or acidic pH with the rate

decreasing with increasing pH. The reaction was strictly bimolecular in the pH range of 9.5-11.6, where it was sufficiently slow to be followed with time. The reaction appears to proceed between nitrous and hypochlorous acid molecules. (Author's abstract)
W91-04950

ANAEROBIC DECHLORINATION/DEGRADATION OF CHLORINATED ORGANIC COMPOUNDS OF DIFFERENT MOLECULAR MASSED IN BLEACH PLANT EFFLUENTS.
Svenska Traeforskningsinstitutet, Stockholm.
R. Fitzsimons, M. Ek, and K. L. Eriksson.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1744-1748, November 1990. 4 fig, 2 tab, 11 ref.

Descriptors: *Anaerobic digestion, *Bleaching wastes, *Dechlorination, *Industrial wastewater, *Pulp and paper industry, *Wastewater treatment, Degradation, Halogenated organic compounds.

Anaerobic dechlorination/degradation of high molecular mass material in bleach plant effluent was investigated in different systems. A decrease in organically bound chlorine, measured as adsorbable organic halogen(AOX) was found with all molecular mass fractions. The rate and extent of dechlorination and degradation of soluble AOX decreased with increasing molecular mass. Part of the dechlorination appears to be dependent on readily degradable carbon sources. The possibility that degradation is a combination of chemical depolymerization or desorption of small molecules followed by their biological degradation cannot be excluded. In these experiments, the rate of dechlorination of high molecular mass material proceeded too slowly to be of any practical use in effluent treatment. (Author's abstract)
W91-04955

REMOVAL OF CU AND CD FROM WATER BY BACOPA MONNIERI L.
National Botanical Research Inst., Lucknow (India). Aquatic Botany Lab.
For primary bibliographic entry see Field 5B.
W91-04980

SEPTAGE-ONLY TREATMENT PLANT OPENS AFTER 19 YEARS OF HURDLES.
Linenthal Eisenberg Anderson, Inc., Boston, MA.
B. Fehan, and P. Guertin.
Public Works PUWOAH, Vol. 121, No. 11, p 46-48, October 1990.

Descriptors: *Cape Cod, *Massachusetts, *Septic wastewater, *Wastewater facilities, *Wastewater treatment, Archaeology, Biological oxygen demand, Effluents, Groundwater protection, Nitrates, Social aspects.

One of the country's first septage-only treatment plants has begun operation on Massachusetts's Cape Cod. The regional $13 million facility treats 45,000 gpd of septage from the towns of Orleans, Brewster and Eastham. The design process had to overcome several obstacles: public resistance to any type of sewered option; the town's location in a groundwater protection district with strict architectural requirements; and the discovery that the site contained significant archaeological resources. Present operations are finding effluent BOD and suspended solids running at approximately 10 mg/L, well below the discharge permit of 30 mg/L of both parameters. The nitrogen levels are also running well below the permit requirements of 50 mg/L. (Author's abstract)
W91-05025

UTILITY FINANCIAL PLANNING AND RATE DESIGN BY COMPUTER.
Kalamazoo City Dept. of Public Utilities, MI.
J. A. Barnett-Moore, W. G. Standard, and B. D. Foster.
Public Works PUWOAH, Vol. 121, No. 11, p 56-59, 115, October 1990. 5 fig.

Descriptors: *Computers, *Management planning, *Metropolitan water management, *Utilities, *Wastewater treatment, *Water treatment, Computer models, Computer programs, Industrial wastes, Michigan, Sewage rate, Water rates.

The city of Kalamazoo, Michigan owns and operates water supply and wastewater treatment systems that provide service to approximately 150,000 residents as well as business and industry in the city and the surrounding metropolitan area. Service outside the city is provided both on a retail and wholesale basis through contracts with 17 townships and municipalities. The city also provides wastewater collection and treatment service to three major industries by separate service contracts. The city selected Lotus 1-2-3 Release 2.2 spreadsheet software to develop customized financial planning and rate models to enable routine revisions and updates of revenue requirements, cost allocations and rate schedules. (Author's abstract)
W91-05026

HISTORIC TOWN RECYCLES HISTORY FOR WASTEWATER TREATMENT.
Camp, Dresser and McKee, Inc., Cambridge, MA.
F. Requena, and H. W. Storrs.
Public Works PUWOAH, Vol. 121, No. 11, p 63-65, October 1990.

Descriptors: *Massachusetts, *Sludge digestion, *Upgrading, *Wastewater facilities, *Wastewater treatment, *Water quality standards, Chlorination, Concord River, Sand filters, Settling tanks, Sludge drying, Trickling filters.

The town of Concord, Massachusetts has recycled its turn-of-the-century treatment plant which originally contained four unlined natural sand filter beds to meet the demands of an increased population and to meet state and federal discharge permits. By 1980, five more filter beds were added; a primary settling tank with anaerobic sludge digestion and sludge drying beds were installed; chlorination facilities and underdrains piped the effluent to the Great Meadows Wildlife Sanctuary, a large marshland between the plant and the Concord River; and the effluent discharge outfall was extended to the Concord River. The system was designed to handle a 1-mgd flow, but could only treat about 0.70 mgd and still meet its National Pollutant Discharge Elimination System (NPDES) discharge permit requirements. A combination of plastic-trickling filters and upgraded sand filter beds was installed. As a result, the plant can now handle 1.2 mgd of effluent and the effluent parameters are below the NPDES permit requirements. (Feder-PTT)
W91-05027

LIGHTING GUIDE FOR WASTEWATER TREATMENT FACILITIES.
General Electric Co. Lighting Systems, Hendersonville, NC.
C. Laughter.
Public Works PUWOAH, Vol. 121, No. 11, p 69-70, October 1990.

Descriptors: *Lighting, *Wastewater facilities, *Wastewater treatment, Construction, Design criteria, Energy costs, Engineering.

For wastewater-treatment operations to run smoothly day and night, workers must have good visibility around outdoor settling and aeration tanks and indoor sludge-removal equipment. Stanchion-mounted outdoor lights should be installed where workers monitor wastewater and take core samples. Stairs and truck-loading stations must also be well lit. For hazardous and/or corrosive environments, hazardous-location fixtures are recommended. For any outdoor location, fixtures should have a 'Suitable for Wet Locations' listing from the Underwriters Laboratories and should be made of corrosion-resistant materials and/or have a corrosion-resistent finish. High-mast lighting systems provide general illumination for a large facility. Floodlights and wall mounted fixtures are also useful in indoor locations. Hazardous-location fixtures should be chosen for indoor locations that are or may be hazardous or corrosive. In non-hazardous treatment areas, industrial fixtures are a good choice. High-pressure sodium lamps are the most energy-efficient light sources. (Feder-PTT)
W91-05029

SLUDGE MADE MANAGEABLE WITH WEDGEWATER FILTER BEDS.
Kalamazoo City Dept. of Public Utilities, MI.
C. G. Wilmut, T. T. Palit, and T. Decell.
Public Works PUWOAH, Vol. 121, No. 11, p 76-78, October 1990. 2 fig, 1 tab.

Descriptors: *Filter media, *Sludge drying, *Sludge filters, *Sludge treatment, *Waste management, *Wastewater treatment, Filtration, Flocculation, Polymers, Sludge solids.

The Wedgewater filter bed system utilizes either stainless steel media or high density polyurethane media. This system works on the same principle as a conventional sand/gravel drying bed. However, the Wedgewater's loading capacity (about 2 lb of dry solids per sq ft) is about twice as high as the sand/gravel beds. Properly operated under favorable environmental conditions, the sludge reaches a solids content of 15 to 20 percent in about three or four days on the filter beds. Efficient sludge flocculation was achieved through the use of polymer handling/injection equipment. (Author's abstract)
W91-05030

FORMULATING STRATEGIES FOR ACTIVATED SLUDGE SYSTEMS.
Environmental Resources Management, Inc., Exton, PA.
A. F. Rozich, and R. J. Colvin.
Water Engineering and Management WENMD2, Vol. 137, No. 10, p 39-41, October 1990. 5 fig.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Process control, *Respirometry, *Waste management, *Wastewater treatment, Chemical oxygen demand, Management planning, Model studies, Oxygen uptake, Toxicity.

For enhancing biological wastewater treatment systems, respirometric methods can be used to enhance treatability studies and the application of predictive models for process control. The primary advantages of respirometry are that it streamlines the traditional treatability study and that it adds a set of data (oxygen uptake) which allows the analyst to crosscheck chemical oxygen demand or specific compound-removal data. Individual respirometric tests can be run in one day or less, which means this technique could be used as a proactive process-control tool. These techniques are applied in either a predictive modeling mode or a screening mode. The predictive modeling mode enables management to define capacity, optimize operating policies or institute programs designed to keep the facilities in compliance. The screening mode is designed to identify the constituents of influent waste which tend to be recalcitrant and which contribute to effluent toxicity or COD. (Feder-PTT)
W91-05036

ABCS OF SRFS.
R. A. Blattner, and T. S. Davis.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 12, p 54-56, December 1990.

Descriptors: *Financing, *State revolving funds, *Wastewater facilities, Cost analysis, Government finance, Ohio.

Wastewater treatment plants in the United States are deteriorating faster than they can be repaired and the outlook for future federal funding is bleak. State and local governments will have to rely on their own resources to fund the plant expansions and upgrades needed to meet Environmental Protection Agency treatment regulations. According to a 1988 EPA survey, more than $83.5 billion dollars will be needed to meet wastewater requirements through 2008. Of the various financing alternatives available, the State Revolving Fund (SRF) Loan Programs appear to be favored in cost-benefit analysis. Communities can use the SRF in sever-

al ways: (1) the fund can lend money, but loans must be made at or below market interest rates and amortized no more than 20 yr after project completion; (2) the SRF can be used to refinance existing debt obligations incurred for construction of publicly owned wastewater treatment projects after March 7, 1985; (3) an SRF can guarantee local debt obligations to improve credit market access or reduce interest rates; (4) SRF resources can be leveraged to increase the value of the fund without obtaining additional money from the state; (5) an SRF may provide loan guarantees for similar revolving funds established by municipalities or inter-municipal agencies; (6) an SRF may earn interest on fund accounts prior to a loan disbursement; and (7) money in the SRF may be used for reasonable administrative costs provided the amount does not exceed 4% of all SRF capitalization grants awarded. The 20-yr-old SRF program in Ohio was used by the EPA as a model for the national program. By offering loans at 2-5% interest, savings equivalent to a 40-20% grant are obtained. On the whole the SRF loan program offers a bright alternative for communities to refinance their wastewater treatment needs. (Rochester-PTT)
W91-05071

VENTURI AERATION AND THERMOPHILIC AEROBIC SEWAGE SLUDGE DIGESTION IN SMALL-SCALE REACTORS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
P. Burt, M. H. Littlewood, S. F. Morgan, B. N. Dancer, and J. C. Fry.
Applied Microbiology and Biotechnology AMBIDG, Vol. 33, No. 6, p 721-724, September 1990. 1 tab, 1 fig, 14 ref.

Descriptors: *Aeration, *Aerobic digestion, *Sludge digestion, *Sludge treatment, *Thermophilic bacteria, *Wastewater treatment, Chemical oxygen demand, Hydrogen ion concentration, Sludge solids, Small-scale reactors, Venturi meters, Wastewater reactors.

The aeration performance of two venturi aeration reactors (operating volumes 38 L and 25 L) was studied for an air-water system. It was found that the mass transfer coefficient could be described in terms of the superficial gas velocity (Vs) alone in a simple relationship. A similar relationship was obeyed when the 38-L reactor was aerated with a diffuser tile. A linear relationship between the mass transfer coefficient and gas hold-up was observed for the 38-L reactor with both venturi and diffuser aeration. The 25-L reactor was used successfully for the thermophilic aerobic digestion of sewage sludge. A mean sludge temperature rise of 30 C was observed. Chemical oxygen demand, pH, and total solids content of the digested sludge differed significantly from the feed sludge and were similar to values obtained for full-scale thermophilic aerobic digestion. No significant differences between inorganic solids content, dissolved oxygen concentration, or redox potential were observed between feed and digested sludge. It is concluded that thermophilic aerobic digestion with the venturi aerator is possible over a range of scales suitable for laboratory, intermediate scale, and industrial purposes. (Author's abstract)
W91-05094

MICROBIAL POPULATIONS AND SLUDGE CHARACTERISTICS IN THERMOPHILIC AEROBIC SEWAGE SLUDGE DIGESTION.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
P. Burt, S. F. Morgan, B. N. Dancer, and J. C. Fry.
Applied Microbiology and Biotechnology AMBIDG, Vol. 33, No. 6, p 725-730, September 1990. 3 fig, 1 tab, 23 ref.

Descriptors: *Aerobic digestion, *Sludge analysis, *Sludge digestion, *Sludge treatment, *Thermophilic bacteria, *Wastewater treatment, Bacterial analysis, Bacterial growth, Coliforms, Population density, Populations, Process control, Temperature effects.

Estimates of bacterial numbers from raw sewage sludge and sludge treated by thermophilic aerobic digestion were compared with simple indicators of sludge quality and concentrations of potential substrates. Significant differences were found between sludge types for all but one of the variables examined (frequency of dividing cells). During a stable period of digestor operation, the average number of viable obligate thermophiles present in digested sludge (1.63 million/ml) was approximately 100-fold greater than in feed sludge (11,000/ml). Total numbers of bacteria were slightly greater in digested sludge (32.4 billion/ml) than in feed sludge (23.9 billion/ml), as were viable counts of bacteria at incubation temperatures of 37 C and 55 C. Significant correlation was found between viable counts of bacteria 37 C and 55 C for digested sludge, and 65 C and 55 C for feed sludge. The numbers of obligate thermophiles present and the total numbers of bacteria present were related to the temperature and pH of the digested sludge and inversely to the numbers of Escherichia coli and coliforms present, which were not detected at temperatures greater than 50 C. It is concluded that temperature has a major influence on the thermophilic aerobic digestion process and that the role of bacterial populations merits study in future work on process optimization. (Author's abstract)
W91-05095

COMPARISON OF CADMIUM BIOSORPTION BY GRAM-POSITIVE AND GRAM-NEGATIVE BACTERIA FROM ACTIVATED SLUDGE.
New Jersey Inst. of Tech., Newark. Biotechnology Research Group.
R. Gourdon, S. Bhende, E. Rus, and S. S. Sofer.
Biotechnology Letters BILED3, Vol. 12, No. 11, p 839-842, November 1990. 1 fig, 1 tab, 13 ref.

Descriptors: *Activated sludge, *Bacteria, *Bioaccumulation, *Biological treatment, *Cadmium, *Wastewater treatment, Bacterial analysis, Bacterial physiology, Biosorption, Heavy metals, Hydrogen ion concentration.

Gram-positive and Gram-negative bacteria were isolated from activated sludge and used to evaluate differences in cadmium biosorption. Gram-positive bacteria exhibited approximately 20% more cadmium biosorption at 30 C and pH 6.6 than did Gram-negative bacteria. Biosorption increased significantly with pH in both cases. Biosorption was largely passive in both cases, although metabolic uptake appeared to occur to a higher extent with Gram-positive bacteria. It is suggested that glycoproteins on the outer side of the cell wall in Gram-positive bacteria may be responsible for the difference in cadmium biosorption between Gram-positive and Gram-negative bacteria. (MacKeen-PTT)
W91-05099

SUBSTRATE INHIBITION OF PHENOL OXIDATION BY A STRAIN OF CANDIDA TROPICALIS.
Cranfield Inst. of Tech. (England). School of Water Sciences.
T. Stephenson.
Biotechnology Letters BILED3, Vol. 12, No. 11, p 843-846, November 1990. 2 fig, 1 tab, 8 ref.

Descriptors: *Activated sludge process, *Biodegradation, *Biological wastewater treatment, *Phenols, *Wastewater treatment, *Yeasts, Culturing techniques, Kinetics, Organic compounds, Oxidation, Sludge, Substrate inhibition.

Removal of phenol from wastewaters can be achieved through aerobic biodegradation in activated sludge plants. Pseudomonas putida is a species commonly found in sludge plants and capable of using phenol as a major carbon source. After unsuccessful attempts to grow P. putida in shake flasks on phenol, a surviving fungal culture, identified as Candida tropicalis, was obtained. The kinetics for growth on phenol by C. tropicalis were investigated in batch culture and by respirometry. The culture was tolerant of an initial phenol concentration of up to 1.5 g/L. The optimum temperature for phenol oxidation was 32 C and below this temperature the Arrhenius relationship was obeyed. A Michaelis-Menten relationship described the substrate inhibition of the Candida by phenol. The results indicated that there was less substrate inhibition of phenol oxidation at temperatures below the optimum and that the model for that inhibition cannot be applied at or below 25 C. (MacKeen-PTT)
W91-05100

SCREENING OF WHITE-ROT FUNGI FOR EFFICIENT DECOLOURIZATION OF BLEACH PULP EFFLUENTS.
Pontificia Univ. Catolica de Chile, Santiago. Dept. of Chemical Engineering.
G. Galeno, and E. Agosin.
Biotechnology Letters BILED3, Vol. 12, No. 11, p 869-872, November 1990. 2 fig, 1 tab, 15 ref. UNDP Grant CHI/87/021.

Descriptors: *Biological wastewater treatment, *Bleaching wastes, *Fungi, *Industrial wastewater, *Pulp wastes, *Wastewater treatment, Biodegradation, Chile, Decolorization, Effluents, Lignin, Pulp and paper industry.

Several white-rot fungi collected in the South of Chile were evaluated for their ability to decolorize kraft pulp bleached effluents. All four strains studied decolorized the brownish effluent to a clear yellow solution. No apparent adsorption of chromophores on the surface of the mycelium was observed, suggesting that the colored components of the effluent were biochemically decomposed and not simply adsorbed. Strain 158, recently identified as a Ramaria sp., showed the highest potential for the biological treatment of E1 effluent: 90% of the color was removed by this strain grown under air, with a similar rate and extent of decolorization as Phanerochaete chrysosporium under oxygen. Significant decrease of the high molecular weight fraction, as well as the appearance of new low molecular weight aromatic compounds, indicated that the chlorolignins were significantly depolymerized. However, neither strain was able to completely degrade the high molecular weight chlorinated lignin compounds found in the E1 effluent. (MacKeen-PTT)
W91-05101

LIKELIHOOD OF SIGNIFICANT COST REDUCTIONS IN DESALINATION.
Ewbank Preece Consulting Ltd., Brighton (England).
For primary bibliographic entry see Field 3A.
W91-05193

EXPERIMENTAL STUDY ON INTEGRATED MEMBRANE PROCESSES IN THE TREATMENT OF SOLUTIONS SIMULATING TEXTILE EFFLUENTS: ENERGY AND EXERGY ANALYSIS.
Universita di Reggio Calabria, Cosenza (Italy). Dept. of Chemistry.
V. Calabro, G. Pantano, M. Kang, R. Molinari, and E. Drioli.
Desalination DSLNAH, Vol. 78, No. 2, p 257-277, August 1990. 13 fig, 6 tab, 15 ref.

Descriptors: *Industrial wastewater, *Textile mill wastes, *Wastewater treatment, *Reverse osmosis, *Membrane distillation, *Membrane filters, *Wastewater facilities, *Energy equation, *Dye industry wastes, *Mathematical models, Hydrodynamics, Chemical recovery, Chemical wastewater, Membrane processes, Fouling.

Experiments on a reverse osmosis (RO) pilot plant and a membrane distillation (MD) laboratory plant were made using simulant fluids. Hydrodynamic behavior, rejection characteristics of the modules, maximum attainable concentration, permeate flow decay, fouling of the modules by simulant components, and suitable cleaning techniques were studied. Some cycles for recovering dyes and chemical auxiliaries were also proposed. For each cycle an energy and exergy (the maximum useful work that a system can do when it passes from an actual state to the reference state where it is in equilibrium with the surroundings) analysis was developed for evaluating the efficiency in using the energy and

for comparing the cycles without recovery and those with recovery in which different integrated membrane processes were used. An energy and exergy analysis was applied to a simulant textile cycle with reverse osmosis recovery and with a sequence of RO+MD recovery. With respect to the cycle without recovery, significant energy and exergy decreases for both the cycles were obtained. Further decrease in the required energy and exergy for the RO+MD with respect to the RO was also observed. In principle, this showed a convenience in using integrated RO+MD plants for obtaining concentrate solutions. Experiments on concentration of salts and dye solutions by RO showed good performances for the modules used. Cleaning procedures had a reversible fouling by the various aqueous salt solutions in the range of tested concentrations. When dyes were used, cleaning was relatively more difficult and an irreversible decrease in the flux was observed. For dye concentrations, the results indicate it was possible to reach dye concentration on the order of 40-50 g/l in the MD plant. (Medina-PTT)
W91-05198

DYNAMIC DATA ON LEAD UPTAKE FROM WATER BY CHABAZITE.
Naples Univ. (Italy). Dipt. di Ingegneria dei Materiali e della Produzione.
M. Pansini, and C. Colella.
Desalination DSLNAH, Vol. 78, No. 2, p 287-295, August 1990. 5 fig, 20 ref.

Descriptors: *Industrial wastewater, Ion exchange, Heavy metals, *Italy, *Chabazite, *Wastewater treatment, *Zeolite, Tuff, *Lead, Mathematical models.

The possibility of using chabazite, a natural zeolite exchanger, for lead removal from wastewaters was examined, testing fixed beds made of Campanian tuff, a volcanic rock rich in such zeolite using the mass transfer zone method. Chabazite tuff bed use for lead removal from water was best when lead concentrations were not too high and flow rates did not exceed about 10 ml/min. Lead breakthrough curves, as a function of pollutant concentration and influent flow rate were determined and dynamic parameters connected with ion exchange operation were mathematically calculated. Dynamic ion exchange tests confirmed the good selectivity of chabazite for lead and suggested that Campanian tuff may be used for removing lead from wastewaters, instead of the usual methods based on precipitation. (Medina-PTT)
W91-05199

EVALUATION OF A SMALL UNSTEADY CONTINUOUS FLOW RBC SYSTEM.
Jordan Univ. of Science and Technology, Irbid. Dept. of Civil Engineering.
A. B. M. Shahalam, and B. Abbassi.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 7, p 785-798, October 1990. 5 fig, 4 tab, 20 ref.

Descriptors: *Biological wastewater treatment, *Rotating biological contactors, *Mathematical models, *Wastewater treatment, Water quality standards, Model studies.

Rotating Biological Contactors (RBC) consist of fixed media of synthetic materials and are often used for the treatment of wastewater from small and medium size cities. This system is basically divided into two parts: the disk and the trough. Parts of the system are related to each other while operating simultaneously to constitute a successful RBC system. An unsteady continuous flow mathematical model of RBC analytically correlates the major biochemical and physical phenomena that occur in the system. The model was calibrated and tested in an operating RBC system located at Irbid, Jordan. Under steady state conditions, the model could predict the performance of the operating plant within a standard error of 2.6% of the average steady state condition in the first stage of the system. Under unsteady conditions, the standard deviation in model prediction of effluent quality measured within the range of 78-132 mg/l was 7.8 mg/(BOD) indicating that the model may be utilized to simulate an RBC system under unsteady state conditions. (Medina-PTT)
W91-05206

SIMULATION MODELING OF PRIMARY CLARIFIERS (CASE STUDY OF DOHA TREATMENT PLANT).
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Coll. of Engineering.
N. S. Abuzeid, S. G. Vellioglu, and G. F. Nakhla.
Journal of Environmental Science and Health (A) JESEDU, Vol. 25, No. 7, p 799-820, October 1990. 8 fig, 6 tab, 9 ref.

Descriptors: *Model studies, *Clarifiers, Regression analysis, *Suspended solids, *Biochemical oxygen demand, *Mathematical models, *Wastewater treatment, Overflow rate, Load distribution, Organic removal, Wastewater facilities, Regression analysis.

Regression models were developed for the removal of suspended solids (SS) and biochemical oxygen demand (BOD) in primary settling tanks at the Doha Municipal Wastewater Treatment Plant in Qatar. Despite poor correlation and variations between the data and existing models, the newly developed expressions for SS removal confirmed the findings of previous research which showed that removal efficiency is a function of the hyraulic loading rate and the influent SS. Although there are relatively few equations for BOD removal in primary clarifiers which establish the correlation between organic removal efficiency on one hand, and influent BOD and SS on the other, the study indicated the importance of the overflow rate as an additional parameter that must not be overlooked. (Author's abstract)
W91-05207

ICA SYMPOSIUM ON INSTRUMENTATION, CONTROL AND AUTOMATION IN WATER AND WASTEWATER MANAGEMENT.
National Inst. for Water Research, Pretoria (South Africa).
Available from the National Technical Information Service, Springfield, Virginia 22161, as PB89-175079. Price codes: E07 in paper copy, E07 in microfiche. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). 99p.

Descriptors: *South Africa, *Monitoring, *Automation, *Water treatment facilities, *Wastewater facilities, Industrial wastes, *Instrumentation, Computers, Probes, Pumps, Data processing, Data acquisition.

The use of various instrumentation, control systems, and automatic monitoring systems was evaluated and described based on case studies from South Africa. Types of systems examined include ion measuring probes, flow monitoring, automatic pumps, gas meters, and others. Systems were described for industrial uses, water treatment plants, and wastewater facilities. In addition computer systems for processing data and monitoring results were evaluated. (See W91-05282 thru W91-05299) (White-Reimer-PTT)
W91-05281

AUTOMATED FLOW AND PH CONTROL IN A PILOT PLANT FLUIDIZED BED REACTOR.
Rand Water Board, Johannesburg (South Africa).
J. C. Geldenhuys.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 25-28.

Descriptors: *Wastewater treatment, *Process control, *Hydrogen ion concentration, *Fluidized beds, *Calcium, *Chemical precipitation, Hardness, Calcium oxide, Calcium carbonate, Lime, Flow rate, Electrodes, Automation.

The automated control of flow and pH in a pellet bed reactor in which calcium oxide is recovered in the form of calcium carbonate was investigated. Successful operation of the unit treatment process depends heavily on a steady flow through the fluidized bed and accurate pH control. Calcium hydroxide is added in the form of slaked lime and the newly formed calcium carbonate crystallizes on the seed material in the fluidized bed. Calcium carbonate removed from the reactor is calcined, then slaked and recycled through the reactor in the form of calcium hydroxide. Since the objective is to recover as much as possible of the calcium oxide (dosed as lime), the pH must be controlled within the strict limits in which the stoichiometric reaction takes place. The flow control is based on the principle that a specific flow rate in a pipe will exercise a corresponding pressure. For this reason the feed line to the reactor was fitted with a differential pressure meter over an orifice plate. The fluidized pellet bed reactor is run continuously and the pH control system should respond rapidly to pH changes in the feed water. The pH control system comprises a pH meter fitted with a continuous cleaning revolving antimony electrode coupled to a programmable pH/mv transmitter/controller and a variable speed positive displacement cavity pump. Alterations in the lime feed rate take place as a result of deviations from the pH required in the effluent from the reactor. The rate at which the lime dosage is adjusted is controlled through the programmable transmitter/controller. Because of the inherent simplicity and robustness of the system, maintenance is very low. The automated unit has been running for three years, and has been out of service only to replace worn-out parts in the lime feed pump. (See also W91-05281) (White-Reimer-PTT)
W91-05283

INSTRUMENTATION, CONTROL AND AUTOMATION IN WATER AND WASTEWATER MANAGEMENT ELANDSJAGT WATER TREATMENT WORKS.
Ninham Shand, Inc., Cape Town (South Africa).
For primary bibliographic entry see Field 5F.
W91-05286

CONFIGURATION OF COMPUTER BASED CONTROL SYSTEMS FOR WASTEWATER TREATMENT PLANTS.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
E. W. Randall, and P. L. Dold.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 49-51, 1 fig.

Descriptors: *Control systems, *Wastewater treatment, *Measuring instruments, Data transmission, Remote sensing, *Computers, *Wastewater facilities, *Automation, Monitoring, Process control, Economic aspects, Telemetry.

Wastewater treatment computer control and monitoring systems generally comprise a central computer transmitting to and receiving information from a number of remotely situated control elements and monitoring instruments. A necessary part of the system is the link between the remote devices (instruments, valves, etc.) and the computer. Current technology enables the use of digitally encoded signal transmission which is superior to conventional telemetry in terms of speed and reliability. The hardware configuration suitable for a treatment plant application requires a host computer which carries out the numerical analysis, control functions, data logging and display. The host computer is linked to one or more remote serial interface units for performing the input/output and in some cases limited local data reduction and distributed control tasks. This approach to the implementation of process control and monitoring systems has been proved viable and cost effective. A system can be set up using any computer with a serial port and by constructing the serial interface unit from commercially available modules. (See also W91-05281) (White-Reimer-PTT)
W91-05288

INSTRUMENTATION FOR ROOIWAL WATERCARE WORKS.
Meiring and Partners, Pretoria (South Africa).
J. L. Barnard, and J. R. Hoffman.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 52-57, 3 fig.

Descriptors: *Activated sludge process, *Nutrient removal, Sensors, Trickling fitlers, Industrial wastes, *South Africa, *Wastewater facilities, *Automation, *Instrumentation, Air control, Blowers, Computers.

The Rooiwal Watercare Works in South Africa consists of a nutrient removal activated sludge plant incorporating a trickling filter plant and has a population equivalent of about 1,000,000. A substantial portion of the flow originates from industries in Rosslyn, South Africa, one of which is a brewery. The plant was designed to have 6 modules with a later extension to 8 modules. Air is supplied to the fine bubble diffused air system from a central blower house by means of three and later four blowers. The blower control system is intricate and at the time of tendering, the control system was included as part of the tender to avoid splitting of responsibility. The blower control has to ensure that all the conditions are correct before startup of a blower and has to adjust the inlet vanes to a low setting during startup. The surge must be open during startup and must be closed when the running speed is achieved. An increased air demand is accomplished by either opening the inlet vanes more, or when fully open, by starting up another blower while coordinating the vanes for both blowers to have the same setting. In application it was found that the control system for the air output worked well as long as the blower control system was functional but problems were experienced with the balancing of the flow to the various modules. To eliminate this situation, consideration is being given to the possibility of using the air flow meters to the modules for controlling the flow distribution. Due to the large number of probes one should be able to get reasonable control even with a number of the probes defective, while the distribution will not be solely dependent on the probes. (See also W91-05281) (White-Reimer-PTT)
W91-05289

CHEMICAL PHOSPHATE REMOVAL AT BOKSBURG WATER POLLUTION CONTROL WORKS: AUTOMATION AND CONTROL.
Boksburg Town Council (South Africa).
A. S. Louw.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 58-65, 3 fig, 1 tab.

Descriptors: *Phosphate, *South Africa, *Control systems, Water pollution control, Biological filters, Anaerobic digestion, Wastewater analysis, *Phosphorus removal, *Wastewater treatment, *Chemical treatment, Automation, Instrumentation, Hydrogen ion concentration.

A study was conducted to optimize the chemical usage for the removal of phosphates from biological filter plant effluents and quantify the additional sludge production caused by phosphate removal for the Vlakplaats Water Pollution Control Works in South Africa. The facility consists of three virtually identical self-contained biological filtration units in parallel, each designed to treat 18 Ml/d with its own independent inlet works, primary settlers, biological filters, humus tanks and anaerobic sludge digesters. The chemical dosing strategies considered were: (1) constant volume dosing; (2) dosing proportional to flow; and (3) dosage proportional to flow with adjustment for varying phosphate concentration on different days of the week. A daily dosage rate was found to be the best approach coupled with an on-line continuous monitoring system. The system that was the most practical at the Vlakplaats Works was to sample the effluent recycle proportional to flow, using an automatic liquid sampler and then to analyze the samples in the laboratory. The pH of the chemically treated humus tank effluent was monitored and recorded continuously using a radiometer pH meter and stripchart recorder. As a rule the pH varied very little, in the range of 7.0 to 7.3. (See also W91-05281) (White-Reimer-PTT)
W91-05290

GAS METERING AT SEWAGE PURIFICATION WORKS.
Stewart, Sviridov and Oliver, Marshalltown (South Africa).
F. F. Kolbe.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 66-69.

Descriptors: *Measuring instruments, *Flow measurements, *Wastewater facilities, *Digesters, *Digester gas, *Instrumentation, Meters, Flow, Calorimetric meters, Displacement meters, Head loss meters.

Accurate and reliable metering of digester gas production and consumption at a sewage purification works is complicated by the low pressures involved and by the aggressive nature of the gas. Accurate metering of gas production is made more difficult by the highly variable pattern of gas generated by an individual digester. The rate of gas production rises very steeply within 15 minutes of feeding in a healthy digester, to at least 250% or even 500% of the average production, depending on the feed cycle. This production then gradually tapers to as low as 10% of the average, depending on the feed cycle. The solution is to feed each digester on as steady a basis as possible. The types of meters that have been considered are: displacement meters, which are of the semi-positive or inferential type, with construction basically similar to a water meter; loss of head meters, which indicates both the rate of flow and quantity; and calorimetric meters, which measures the calorimetric value of the gas flowing in the pipeline. At this time inferential meters are generally used to measure gas consumption, as in an engine or incinerator, where the flow rate is relatively steady and accurately defined. In this situation a meter with both an acceptably low loss of head and high accuracy would be selected. The newer, but untried, calorimetric meter is better used on a digester gas collection pipe, where its wide range and lack of interference with the flow of gas, make it a natural choice. (See also W91-05281) (White-Reimer-PTT)
W91-05291

DATA CAPTURE SYSTEMS AT THE JOHANNESBURG NORTHERN WORKS.
Johannesburg City Health Dept. Labs. (South Africa).
C. S. Stevens.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 70-75, 2 fig, 1 tab.

Descriptors: *Water quality control, Performance evaluation, Effluents, Data storage and retrieval, *Wastewater facilities, *Monitoring, *Instrumentation, South Africa, Automation, Computers, *Data acquisition, Data processing.

The use of on-line monitors to record effluent quality and plant performance on large sewage works has become common practice world-wide. These monitors rapidly generate vast quantities of data which have to be captured, processed, stored, utilized, and interpreted. Two data capture systems developed at the Northern Works in South Africa are a purchased commercial logger system, and complementing this, an in-house system based on a personal computer. The Northern Works is equipped with both two-stage biological filters and a nutrient removal activated sludge plant. Parameters being monitored are pH, alkalinity, nitrate, ammonia, phosphorus, oxygen, and redox potential. All the monitoring instruments are linked to an office block where two parallel data capture systems are located. All instruments except the respirometers are connected to the Envirologger which is designed to operate in a network where each site logger is linked by telephone to a central host computer. The logger has the ability to turn equipment on and off, at user-defined times, thus initiating automatic calibration by the monitors. It also detects parameter limits, enabling it to turn chemical equipment on or off. Data capture systems which monitor sewage works effluent quality, provide a continuous and immediately available source of information to works management. (See also W91-05281) (White-Reimer-PTT)
W91-05292

COMPUTERISED INSTRUMENTATION AND CONTROL SYSTEMS.
Lektratek Marketing, P.O. Box 1257, Rivenia 2128, South Africa.
For primary bibliographic entry see Field 7B.
W91-05293

D.O. CONTROL: EXTENT OF PROBLEM IN SOUTH AFRICA.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
P. L. Dold, and G. R. Marais.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 79-81, 2 tab.

Descriptors: *Wastewater facilities, *Activated sludge process, *Dissolved oxygen, *South Africa, *Process control, Instrumentation, Nutrient removal, Monitoring, *Water quality control, Control systems, Performance evaluation.

A survey was carried out in 1986 by the University of Cape Town, South Africa, in collaboration with the Water Research Commission, to assess the extent to which process control problems are experienced in South African wastewater treatment plants. Monitoring instrumentation information was reported in two categories: (1) plants with monitoring instrumentation, and (2) plants with monitoring instrumentation other than flow measuring instruments. The results of the survey indicated that activated sludge plants have the greatest number of control problems because of the greater complexity of the process. This process has expanded performance objectives and a larger number of variables that can be adjusted (oxygen input rate, recycle rates, etc.) than bio-filters. For activated sludge plants the principal control problem encountered revolves around dissolved oxygen control. The problems associated with dissolved oxygen control are: (1) sixty-eight percent of the control systems do not operate satisfactorily; (2) the problem is most prominent in biological nitrogen and phosphorus removal systems; and (3) the factors affecting dissolved oxygen control are unreliable monitors and inappropriately configured control systems. (See also W91-05281) (White-Reimer-PTT)
W91-05294

DEMINERALISATION EFFLUENT PURIFICATION BY VACUUM DISTILLATION.
ISCOR Ltd., Newcastle (South Africa).
R. De Beer.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 82-83.

Descriptors: *Waste recovery, *Effluents, Control systems, Process control, *Wastewater treatment, *South Africa, *Demineralization, *Vacuum distil-

lation, Evaporation, Vertical evaporator, Instrumentation.

Effluent water from a demineralization plant was pumped to 4 evaporation dams; however, expansion of the plant caused the dams to overflow. An investigation of the problem resulted in the decision to recover the effluent would be more economical than expanding the evaporation dam capacity. A multi-effect vertical tube evaporation plant was erected that consisted of two sections: (1) a pre-treatment section for neutralization and filtration; and (2) a concentration section for evaporation by means of vacuum distillation. Neutralized effluent is pumped to the evaporators for purification. Each of the 4 evaporator cells contain a wet leg, extended teflon coated, and metal diaphragm transmitter and impulses from the transmitter are transmitted by means of a dual cable system to the control panel where the levels are manually set for operation. At the base of each effect a manual override controller is installed to provide the facility for emergency level adjustments. Various other temperature, vacuum and level indicators are transmitted to the control panes via a telemetric system for recording. On the whole all the instruments comply to the standards as specified. Most of the problems that occurred during commission of the plant and during the first six months were due to teething problems which have since been resolved. (See also W91-05281) (White-Reimer-PTT)
W91-05295

COMPUTER AUTOMATION IN ANAEROBIC DIGESTION OF BREWERY WASTE.
South African Breweries, Durban.
D. K. Kala.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 84-85.

Descriptors: *Automation, *Instrumentation, *Wastewater treatment, *Industrial wastes, Brewery wastes, Hydrogen ion concentration, Temperature, Organic wastes, *Food-processing wastes, *Anaerobic digestion, Economic aspects, Computers.

In response to the need for a wastewater pretreatment system in a South African brewery, an upflow anaerobic sludge blanket (UASB) process was installed. In order to successfully operate the system it was necessary to constantly monitor the pH, temperature, and organic load. The instrumentation used for monitoring was both static monitoring instrumentation and dynamic monitoring instrumentation. Static monitors only record the parameter values whereas dynamic monitors maintain certain levels by controlling valves and settings. Probes must be cleaned and calibrated, but once the system is running there is minimal maintenance. Because of the level of automation built into the system, it is extremely cost effective both in regard to chemical costs and personnel needed. In addition, due to automation, no time is lost for recovering from process deviation in the biochemical/microbiological control since the digester receives influent of a consistent quality. (See also W91-05281) (White-Reimer-PTT)
W91-05296

PH & RH CONTROL IN METAL SURFACE TREATMENT RECOVERY SYSTEM.
Chemserve Trio (Pty) Ltd., Isando (South Africa).
J. I. Trope.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 86-92.

Descriptors: *Process control, *Metal-finishing wastes, Recycling, *Waste recovery, *Hydrogen ion concentration, *Oxidation-reduction potential, Industrial wastes, *Instrumentation, Probes, Galvanizing, Hydroxides, Precipitation.

The adequacy of presently available equipment for pH and Redox control in a flux regeneration system for recovery and recycling operations was evaluated. Galvanizing operations produce copious amounts of effluent containing iron and zinc. Both of these metals are unacceptable in discharge waters to sewers, and the problem is compounded by the low pH that results from the process. Flux regeneration systems have been installed at a number of plants whereby the effluent from the cold water rinse tank is neutralized using ammonium hydroxide, thus forming ammonium chloride and water, and the increase in pH causes the precipitation of iron hydroxide and zinc hydroxide or forms a zinc amine complex. The process operates very effectively but is based on reliable pH and oxidation/reduction potential control systems. Therefore the electrode cells of the monitoring probes must be maintained at maximum efficiency and sensitivity at all times. However, there is a tendency for the coating of the electrodes and for the plugging of the ceramic liquid junction. A number of different electrode cleaning systems have been designed over the years. These include ultrasonic cleaners, automated brush cleaners, spray systems and others. However, it has been found that the manual cleaning method is the only suitable system for the process. This method consists of removing the electrode from its position in the circuit, cleaning it with a suitable acid or alkaline mixture and brushing the surface of the ceramic junction point before recalibration and return to the measuring tank. The maintenance has to be carried out once every 2-3 days and takes not more than five minutes. (See also W91-05281) (White-Reimer-PTT)
W91-05297

USE OF A DIGITAL CONTROL SYSTEM FOR WATER TREATMENT AND MANAGEMENT AT SAPPI'S ENSTRA MILL.
Sappi Fine Papers (Pty) Ltd., Isando (South Africa).
A. B. Stevens, and H. J. Jacobs.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 93-95.

Descriptors: *Control systems, *Water reuse, *Wastewater treatment, *Water treatment, Economic aspects, *South Africa, *Automation, *Instrumentation, *Industrial water, Pulp and paper industry, Computers, Flocculation, Aluminum, Maintenance.

Sappi's Enstra mill in South Africa is dependant on purified sewage water as part of its water intake. The biologically treated sewage water is upgraded by using a dissolved air flotation process with alum and a polyelectrolyte as a flocculent. The buffer storage for this purified water after the flotation plant is very small and the consumption of water can vary rapidly. A control system is required to keep flocculating chemical concentrations proportionally constant with the throughput of the plant. A microprocessor system was chosen when the system was upgraded. A micro-computer based central processing unit was installed that is supplied with software that allows for the creation of a system to control the plant and allow modification quickly and easily by simply configuring the preprogrammed function modules. Maintenance of the control system is negligible, with only occasional external cleaning of the various units and attention to the hardcopy printer, and regular preventive maintenance on the field measuring and control devices. Due to the optimized flocculation of the sewage water, it was possible to eliminate a host of process problems related to precipitation of aluminimum hydroxide floc on paper machine clothing. This in turn affected the production rate of the paper machines as well as the quality of the paper produced. These benefits have an estimated payback period on the distributed control system of as little as two months. (See also W91-05281) (White-Reimer-PTT)
W91-05298

FOUNDATION CONSTRUCTION WITHIN WASTEWATER-TREATMENT PLANT.
Hampton (Delon) and Associates, Washington, DC.
For primary bibliographic entry see Field 8D.
W91-05317

STEADY-STATE ANALYSIS FOR BIOLOGICAL TREATMENT OF INHIBITORY SUBSTRATES.
Battelle Memorial Inst., Columbus, OH.
S. K. Ong, and A. R. Bowers.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1013-1028, November/December 1990. 7 fig, 3 tab, 31 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Organic pollutants, *Biotechnology, Analytical techniques, Biomass, *Inhibitors, Steady flow, Substrates, Phenols, Biodegradation, Toxic wastes, Wastewater reactors.

The treatment of toxic and inhibitory organic compounds using biological technology has recently been pursued vigorously as a promising treatment option. A steady-state approach for designing biological wastewater treatment systems has been developed for inhibitory substrates using the Haldane rate expression. Steady-state solutions are derived for a continuous-flow completely mixed reactor with recycle of the biomass. It is determined that two steady-state operating regions exist at any one mean cell residence time: an unstable region, where the substrate concentration increases; and a stable region, where the substrate concentration decreases and the biomass concentration increases with mean cell residence time. A critical mean cell residence time is established as a design parameter for inhibitory substrates to maintain a biological reactor in the stable operating region. A survey of published data for phenol exhibits an excellent log-probability relationship for the critical mean cell residence time. For design purposes, the hydraulic residence time is set equal to the critical mean cell residence time. This restricts the mean cell residence time to values higher than the hydraulic residence time, and maintains a reactor in the stable operating region at all times (based on steady-state analysis). For phenol, a very biodegradable inhibitory substrate, the data indicate a log-mean critical mean cell residence time of 0.29 days. However, values of the critical mean cell residence time that guarantee a less-than-1% chance that the critical mean cell residence time will be exceeded are in excess of one day. (Author's abstract)
W91-05318

PILOT-SCALE DISTILLERY SPENTWASH BIOMETHANATION.
National Environmental Engineering Research Inst., Nagpur (India).
P. P. Karhadkar, B. K. Handa, and P. Khanna.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1029-1045, November/December 1990. 7 fig, 4 tab, 17 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Industrial wastes, *Anaerobic digestion, *Methanogenesis, Organic carbon, Biological oxygen demand, Chemical oxygen demand, Dissolved solids, Hydrogen ion concentration, *Biogas, Inorganic compounds, Organic loading, Mathematical models, Volatile acids, Methane.

Distillery spentwash from molasses fermentation is characterized by high biochemical oxygen demand (BOD), high chemical oxygen demand (COD), high total organic carbon (TOC), low pH, high temperature, high dissolved solids, and high concentrations of inorganics. Such spentwash warrants extensive treatment before disposal. Anaerobic processes enabling recovery of biogas appear to offer the most appropriate treatment options. Mesophilic biomethanation of distillery spentwash has been investigated at a pilot scale with a diphasic anaerobic process. An operational strategy to suppress sulfide inhibition through pH control in the methane phase has also been validated. The acid

phase was operated on lime-neutralized spentwash at an organic loading rate of 30 kg COD/cu-m/day. Methane phase operation without solids recycling enabled 65% COD reduction and 0.3 cu-m of biogas production with 60% methane per kilogram COD utilized at an organic loading rate of 3.25 kg COD/cu-m/day. The contact methane phase at 5 kg COD/cu-m/day and 27-day mean cell-residence time achieved 70% COD reduction and 0.3 cu-m gas production with 70% methane per kilogram of COD utilized. An energy audit revealed over 13 times the energy production per unit energy consumed in the process. A mathematical model for the acid phase predicted volatile acid concentrations within 15% of experimental results. The methane phase model incorporated inhibition and was independent of growth or nongrowth-associated phenomena. The model predicted effluent substrate concentrations and gas yields within 10% and 15% of experimental values in the methane phase, respectively. (Author's abstract)
W91-05319

MOLECULAR SIZE DISTRIBUTIONS OF DISSOLVED ORGANIC MATTER.
Arizona Univ., Tucson. Dept. of Civil Engineering.
B. E. Logan, and Q. Jiang.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1046-1062, November/December 1990. 10 fig, 1 tab, 29 ref.

Descriptors: *Water analysis, *Water treatment, *Dissolved solids, *Molecular structure, *Wastewater treatment, *Membrane filters, Dissolved organic carbon, Municipal wastewater, Water treatment, Groundwater pollution, Florida.

The performance of many water and wastewater treatment processes is related to the size distribution of dissolved organics. Discrete molecular size distributions of dissolved organic matter (DOM) in natural waters and wastewaters are usually determined using an array of ultrafiltration membranes in stirred cells. However, many researchers neglect membrane rejection, resulting in an understanding of DOM in low molecular weight size classes. A simple model has been developed, based on a permeation coefficient, that can be used to improve the accuracy of size distributions. Since permeation coefficients are a function of membrane material and water composition, these coefficients must be determined for every water sample. The utility of the model was demonstrated by comparing unadjusted size distributions of dissolved organic carbon (DOC) in groundwater and municipal wastewater. For example, when membrane rejection is neglected, 41% of the DOC in Biscayne Aquifer (Florida) groundwater has an apparent molecular weight greater than 5,000 amu. Size distributions determined using the permeation coefficient model, however, indicate only 16% of the DOC is greater than 5,000 amu. (Author's abstract)
W91-05320

COMPARISON OF SERUM BOTTLE TOXICITY TEST WITH OECD METHOD.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
N. H. Tang, D. J. W. Blum, and R. E. Speece.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1076-1084, November/December 1990. 4 fig, 3 tab, 6 ref. National Science Foundation Grant Number ECE-86-17101.

Descriptors: *Wastewater analysis, *Water analysis, *Wastewater treatment, *Activated sludge process, *Aerobic treatment, Toxic wastes, Industrial wastes, *Toxicity, Analytical methods, *Testing procedures, Organic wastes, Volatility, Phenols.

In 1984, the Organization for Economic Cooperation and Development (OECD) published a procedure to test the effect of a chemical on the respiration rate of activated sludge. Subsequently, in 1987, the OECD published a document promoting the use of this test procedure for control of toxic waste in industrial effluents. The use of closed serum bottles to test the effect of toxicity on aerobic biological activity was initiated in 1989. Each procedure has its strengths and weaknesses; the serum bottle (SB) activated sludge toxicity test and the OECD procedures were compared and contrasted to determine how one technique can complement the other. If the toxicity measurements obtained from the two testing procedures are comparable, users can select either procedure based on time constraint and equipment availability. Seventeen organic toxicants were selected for the comparison. The results show: (1) for chemicals with low volatility, the OECD procedure and SB procedure give comparable results for obtaining the IC50 of organic toxicants; and (2) for volatile chemicals, the SB procedure can be reliably used whereas the OECD procedure cannot because aeration in an open vessel strips out the chemical of interest and the culture is subjected to a concentration decrease with time. Four phenolic compounds were used for studying the effect on the IC50 results due to the origin of the activated sludge. Lab-activated sludge grown on a complex, defined organic medium and sewage-activated sludge gave comparable IC50 results. (Author's abstract)
W91-05322

HEURISTIC DESIGN OF SEWER NETWORKS.
Kuwait Univ., Safat. Dept. of Electrical and Computer Engineering.
C. Charalambous, and A. A. Elimam.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1181-1199, November/December 1990. 4 fig, 5 tab, 12 ref.

Descriptors: *Environmental engineering, *Hydraulic design, *Sewer systems, *Computer-aided design, Mathematical equations, Optimization, Algorithms, Hazen-Williams equation, Mannings equation, Hydraulic engineering, Model testing.

The incorporation of lift stations into sewers introduces considerable complexities in the formulation of sewer network mathematical models and their optimization. A heuristic approach has been developed for the design of sewer networks that can handle the introduction of lift stations and the use of standard diameters. This heuristic approach provides good and logical (rather than optimal) designs of sewer networks. The necessary and sufficient conditions to determine the position of a lift station is first developed in a theorem. Based on this theoretical result, a heuristic design algorithm, using either the Manning or the modified Hazen-Williams hydraulic equation, is developed. The proposed heuristic approach design algorithm takes into account all the structural and hydraulic requirements. The approach was validated and illustrated by designing several hypothetical and two real large sewer networks on a microcomputer. The CPU time for designing sewer networks using the proposed heuristic was less than 10% of the time required for the optimization procedure. Such application indicates the effectiveness of the heuristic approach in rapidly providing 'good' sewer network designs that are comparable to the optimal ones. (Author's abstract)
W91-05328

VELOCITY AND DEPTH OF FLOW CALCULATIONS IN PARTIALLY FILLED PIPES.
Marmara Univ., Istanbul (Turkey). Dept. of Engineering.
For primary bibliographic entry see Field 8B.
W91-05329

MONITORING AND CONTROL OF BIOLOGICAL REMOVAL OF PHOSPHORUS AND NITROGEN BY FLOW-INJECTION ANALYSERS IN A MUNICIPAL PILOT-SCALE WASTEWATER TREATMENT PLANT.
Technical Univ. of Denmark, Lyngby. Dept. of Chemical Engineering.
K. M. Pedersen, M. Kummel, and H. Soeberg.
Analytica Chimica Acta ACACAM, Vol. 238, No. 1, p 191-199, 1990. 10 fig, 9 ref.

Descriptors: *Wastewater treatment, *Monitoring, *Analytical techniques, *Wastewater analysis, *Biological wastewater treatment, *Phosphorus removal, *Nitrogen removal, *Process control, Flow-injection analysis, Municipal wastewater, Pilot plants, Wastewater facilities, Nitrates, Phosphates, Activated sludge process, Colorimetry, Computers, Spectrophotometry, Automation.

Research was conducted to develop closed-loop control strategies for wastewater treatment plants with biological removal of organic matter, nitrogen and phosphorus. In order to establish a good foundation for this work, a flow-injection system was designed and constructed. The system was used for monitoring and control of a biological wastewater treatment plant. The wastewater treatment plant is an activated sludge type on a pilot scale, with municipal wastewater as the influent. The flow-injection system monitors the concentrations of phosphate, ammonia and nitrate in four places: in the inlet, in the outlet of the anaerobic pretreatment tank, in one of the aeration tanks and in the outlet of the plant. Sampling is carried out via a cross-flow filter system, based on an ultrafiltration membrane. The analyzers employ highly pulsating, single-piston liquid chromatographic pumps. Synchronization of injection time and pump pulses eliminates the need for pulse-damping devices and ensures high reproducibility. Chemical methods are based on classical colorimetric methods. The measurement system has been designed with emphasis on long-term stability, low reagent consumption and minimum maintenance. To maintain stable, low flow-rates, on-line degassing has been installed for each reagent. Further, online standard calibration is being used to compensate for drift in the sensitivity of the analyzers. The system is controlled by a personal computer (PC), programmed in ASYST. Calibrated data is fed to a programmable logic controller (PLC), which also controls the pilot plant. A supervisory PC, programmed in Factory Link, stores and presents data. The measurements will be used for studies of different control strategies for the plant, e.g., rule-based control. (Author's abstract)
W91-05331

REMOVAL OF BARIUM ION FROM SOLUTION USING DATURA INNOXIA MILL. SUSPENSION CULTURE CELLS.
Los Alamos National Lab., NM. Life Sciences Div.
P. J. Jackson, A. P. Torres, E. Delhaize, E. Pack, and S. L. Bolender.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 644-648, Oct-Dec 1990. 5 fig, 1 tab, 10 ref.

Descriptors: *Barium, *Biological membranes, *Biological wastewater treatment, *Heavy metals, *Industrial wastes, *Munitions wastes, *Wastewater treatment, Cleanup, Culturing techniques, Decontamination, Explosives, Soil contamination, Water quality standards.

The present method of Ba(++) removal from wastewater generated by explosives manufacturing consists of precipitating the nitrate as a sulfate with subsequent land burial of the sludge. This process will not be able to to meet compliance standards if new guidelines requiring a 100 fold decrease in effluent concentration are adapted. Plant suspension culture cells derived from Datura innoxia anthers rapidly remove Ba(++) from solution. Free Ba(++) is removed as a result of strong interaction with a component of the cell wall. Binding to this component occurs over a wide range of pH and salt concentrations and does not require active metabolism. Cells will remove Ba(++) from nutrient media or from waste solutions that cannot support cell growth. Discharge of untreated effluent prior to the implementation of environmental guidelines has led to the contamination of a number of large sites with this toxic ion. Large scale growth of plant cell suspension cultures to remove this and other toxic ions from industrial effluent together with the development of techniques to regenerate the binding sites and genetic enhancement of selected species may provide a method for the cleanup and removal of toxic substances from soils or effluent prior to discharge. (Doyle-PTT)
W91-05393

DENITRIFICATION IN POROUS MEDIA DURING RAPID, CONTINUOUS LEACHING OF SYNTHETIC WASTEWATER AT SATURATED WATER FLOW.
Hiroshima Univ. (Japan). Faculty of Engineering.
T. Yamaguchi, P. Moldrup, S. Teranishi, and D. E. Rolston.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 676-683, Oct-Dec 1990. 4 fig. 6 tab, 30 ref.

Descriptors: *Denitrification, *Land treatment, *Leaching, *Porous media, *Saturated flow, *Wastewater disposal, *Wastewater treatment, Nitrogen removal, Soil columns, Temperature effects.

Denitrification in six porous media columns (98% decomposed granite or sand and 2% field soil) during saturated leaching at constant flow rates of synthetic wastewater was investigated. Concentrations of NO3-N and methanol between 20 and 60 mg/L were applied and vertical concentration profiles of NO3-N, NO2-N and NH4-N were measured for 45 d at 30 C (three columns) and at 10 C (three columns). A time lag in denitrification of 10 d was found at 10 C. Complete N removal was obtained after 3 d at 30 C but was not obtained at high N-loading at 10 C. A NO2-N leaching was observed between Day 1 and 3 at 30 C. Assuming first-order denitrification at steady state, the corresponding first-order reaction rate coefficients (k 1) for NO3 reduction in the columns were estimated to be between 1.4 and 5.0 per hour at 30 C and between 0.017 and 0.14 per hour at 10 C. The NO3-N concentration in the influent found to be the most optimal for denitrification at steady state was found to be 20 mg N/L at 10 C and 40 mg N/L at 30 C. No significant differences in k 1 values in columns containing decomposed granite and sand, respectively, were found. Steady-state NO3 profiles were obtained between 1.5 and 4.5 wks after the experiments were started. (Author's abstract)
W91-05398

LONG TERM SWINE LAGOON EFFLUENT APPLICATIONS ON 'COASTAL' BERMUDAGRASS: I. YIELD, QUALITY, AND ELEMENT REMOVAL.
North Carolina Agricultural Research Service, Raleigh.
J.C. Burns, L. D. King, and P.W. Westerman.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 749-756, Oct-Dec 1990. 2 fig, 7 tab, 31 ref.

Descriptors: *Bermudagrass, *Hogs, *Land disposal, *Land treatment, *Manure, *Soil contamination, *Wastewater disposal, *Wastewater lagoons, *Water pollution effects, Animal wastes, Holding ponds, Humid areas, Nutrient concentrations, Phytotoxicity, Pollution load.

Swine (Sus scrofa domesticus) confinement systems that use anaerobic lagoons for waste collection in the humid regions require effluent removal during the year. Land area adjacent to the hog facility frequently becomes the site for continuous effluent distribution. The effect of long term application of swine lagoon effluent on dry matter yield, stand persistence, and nutrient concentration and removal in Bermuda grass (Cynodon dactylon) was studied. Effluent loading rates of low (L), medium (M), and high (H), approximating 335, 670, and 1340 kg of N /ha/yr, respectively, were evaluated for 11 yr beginning in 1973 through 1983. The experiment was a randomized complete block with three replicates. Dry matter yields in Year 11 were altered by effluent loading rates with greater production from the M (19.0 Mg/ha) or H (19.6 Mg/ha) compared with the L (13.1 Mg/ha). Although fluxes in stands occurred, they recovered completely as indicated by these yields. Higher concentrations of N, P, K, Mg, Cl, and Zn were present in forage in 1983 compared with 1973. Calcium was unchanged and Cu, Fe, and Na were less. In vitro dry matter disappearance of the forage was similar among loading rates (0.634) in 1983 and greater than in 1973 (0.553). Concentrations of NO3-N were higher in 1978 (1.14 g/kg) compared with 1973 (0.87 g/kg) , but the highest concentrations occurred in 1983 (1.57 g/kg). By 1983, NO3-N concentrations of forages from the H loading rate approached or exceeded the toxic threshold in all summer harvests. Only the H loading (1340 kg/ha) caused unstable stands and eventually produced forage that had NO3-N concentrations potentially toxic if fed as the sole ration to ruminants. Further, it resulted in disproportionally greater quantities of elements, especially N, P, K, Cl, and Na, that remained in the soil environment to become potential soil and soil-water pollutants. (See also W91-05406) (Author's abstract)
W91-05405

FLY-ASH FOR THE TREATMENT OF WATER ENRICHED IN LEAD(II).
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
For primary bibliographic entry see Field 5F.
W91-05463

INDOLACETIC ACID PRODUCTION FROM OLIVE WASTE WATER BY ARTHROBACTER SPP.
Istituto di Radiobiochimica ed Ecofisiologia Vegetale, Rome (Italy).
For primary bibliographic entry see Field 5E.
W91-05483

APPLICATION OF BIOTECHNOLOGY TO MUNICIPAL WASTEWATER TREATMENT.
Public Works Research Inst., Tsukuba (Japan). Water Quality Control Div.
T. Matsui, S. Kyosai, and M. Takahashi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1723-1732, 1991. 19 fig, 7 tab.

Descriptors: *Advanced wastewater treatment, *Biological wastewater treatment, *Biotechnology, *Japan, *Municipal wastewater, *Wastewater treatment, Anaerobic digestion, Biological treatment, Genetic engineering, Microorganisms, Research, Sludge digestion, Sludge treatment, Water pollution.

The Japan Ministry of construction conducted a research project called 'The Development of New Wastewater Treatment Systems Employing Biotechnology,' commonly called Biofocus WT, from 1985 to 1989. Biotechnology was applied to wastewater treatment, including microorganisms banks, genetic engineering application, immobilization of microorganisms, bioreactors for wastewater treatment, bioreactors for sludge treatment, suspended solids separators for raw wastewater, biosensors and new wastewater treatment systems. The data bank provided ecological properties for each strain of microorganism and all strains were classified by their relationship to wastewater systems. The immobilization of microorganisms in bioreactors for wastewater treatment and sludge treatment was useful to increase the concentration of microorganisms in the reactor and to maintain a large amount of microorganisms for the specific removal of particular pollutants. Twenty-three bioreactors were investigated in pilot-plant scale. Aerobic bioreactors, anaerobic bioreactors, multistage reversing flow bioreactors, and bioreactors for nitrogen removal were examined. All the bioreactors incorporated immobilization methods and the main development target was to reduce the retention time in the reactors. Anaerobic sludge digestion processes were developed to shorten the sludge digestion period and to increase the solid decomposition percentage. A self-sustaining energy system was proposed as the ultimate system for an energy-saving wastewater treatment system. (Mertz-PTT)
W91-05499

DESIGN OF MULTI-STORY SEWAGE TREATMENT FACILITIES.
Osaka Municipal Government Bureau of Sewage Works (Japan).
Y. Yuki, E. Takayanagi, and T. Abe.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1733-1742, 1991. 6 fig, 5 tab, 1 ref.

Descriptors: *Japan, *Wastewater facilities, *Wastewater treatment, Aeration, Aerators, Construction costs, Design standards, Osaka, Settling tanks.

In Osaka City, Japan, rising land prices and the rapid advances of urbanization make it difficult to enlarge sites for sewage treatment facilities. To enhance efficient land utilization, construction of multi-story facilities has been promoted. This effort commenced with the building of a two-story primary settling tank, followed by two-story final settling tanks, aeration tanks vertically combined with final settling tanks and three-story final settling tanks. Together with the introduction of these multi-story facilities, efforts have also been made to further deepen the aeration tanks. One feature of the city's multi-story sewage treatment facilities is the use of outlet pipes for purified wastewater in the final settling tanks. This has helped to promote the introduction of multi-story facilities. These multi-story facilities in Osaka City have already been in operation for 10 to 20 years under satisfactory treatment conditions. The area occupied by a multi-story structure is only 46% that of conventional single-story structures. Construction costs for single-story and multi-story structures are almost equal. (Author's abstract)
W91-05500

OPERATION OF CENTRALIZED SLUDGE TREATMENT FACILITIES.
Yokohama City Sewage Works Bureau (Japan). Research and Development Div.
S. Kaneko, and H. Shimomura.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1753-1762, 1991. 6 fig, 6 tab.

Descriptors: *Sludge digestion, *Sludge treatment, *Wastewater facilities, *Wastewater treatment, Digester gas, Digestion, Energy recovery, Incineration, Japan, Recycling, Sludge disposal, Sludge drying, Waste heat.

Construction of sewerage systems in the city of Yokohama has proceeded at a rapid pace ever since the first wastewater treatment plant went into operation in 1962. By 1984, all 11 of the planned wastewater treatment plants were in operation. By March 1989, the sewerage service had reached 80% of the city's residents. The expansion of the sewerage system was reflected in a commensurate increase in the quantity of sludge for treatment and disposal. It was decided to shift from the former decentralized method of sludge treatment at the plant generating it to a method of centralized treatment at two sludge treatment centers, each built within a different wastewater treatment plant located in the waterfront area. The newly constructed centralized sludge treatment facilities featured: the first egg-shaped digestion tanks; a high-concentration mode of digestion made possible by the use of centrifugal thickeners; power generators fueled by digestion gas; effective use of the waste heat from these generators; and the saving of fuel by the use of incinerators equipped with dryers. The quantity of digestion generated at the facility was double that of the former method. Power generation fueled by digestion gas supplied 64% of the facility's own power needs. While operating at only one-fifth of the planned sludge capacity, treatment costs were less than half of the treatment cost of the same quantity utilizing the former method. (Mertz-PTT)
W91-05502

SLUDGE INCINERATION PROCESS OF KYOTO CITY--THE EMPLOYMENT AND HEAT BALANCE OF THE STEP GRATE STOKER FURNACE.
Kyoto City Sewage Works Bureau (Japan). Sludge Treatment Section.
T. Ito.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1763-1772, 1991. 8 fig, 6 tab.

Descriptors: *Incineration, *Japan, *Kyoto, *Sludge drying, *Sludge treatment, *Wastewater treatment, Dewatering, Sludge cake, Sludge disposal, Stoker furnace, Waste management, Wastewater disposal, Wastewater facilities.

Kyoto City has been actively constructing its public sewerage system as one of the most important policies of the city. As of April 1989, 79.6% of the urbanized areas of the city had been sewered. The increased sewered ratio also reflects a steady increase in the influent volume of wastewater. Due to the inland location of the city, sludge produced in the wastewater treatment plants has been landfilled after incineration. Recently, however, the securing of appropriate sites for landfill has became difficult. In order to minimize the ultimate disposal volume, incineration of the entire volume of sludge was undertaken. At present, Kyoto City has four treatment plants in operation. The Toba Treatment Plant, which has the largest treatment capacity, receives sludge cake trucked from the Fushimi Treatment Plant and excess sludge pumped through pipes from the Kisshoin Treatment Plant, and incinerates the entire amount of sludge cake generated at its own plant. Sludge cake produced at the Ishida Treatment Plant is incinerated at an adjacent refuse sanitation plant together with the municipal refuse from the city. A step grate stoker furnace system was introduced to reduce the final disposal volume and to save energy. This furnace incinerates not only the polymer cake but also the lime cake. The sludge cake is sent to an indirect steam dryer where it is dried to a 40% moisture content and then sent to the step grate stoker furnace. The inside of the furnace is a step-shaped structure, with alternating fixed and movable steps. The cake is turned over and lowered gradually to the bottom section through the back and forth motion of the movable steps. In comparison with a multiple-hearth furnace system, the volume of generated ash was decreased by more than 50%. Energy consumption was reduced by 77%, resulting in an 18% reduction of operating expenses. (Mertz-PTT)
W91-05503

OPERATIONAL RESULTS OF MELTING SYSTEM FOR SEWAGE SLUDGE.
Toyama Prefectural Public Works Dept. (Japan). Sewage Div.
D. Yashiki, and T. Murakami.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1773-1781, 1991. 7 fig, 6 tab, 3 ref.

Descriptors: *Japan, *Melting, *Sludge treatment, *Wastewater treatment, Heavy metals, Incineration, Recycling, Slags, Sludge, Sludge disposal, Sludge drying, Waste treatment.

In Toyama Prefecture, Japan, various sludge treatment and disposition systems were investigated in planning the Futakami Sewage Treatment Plant. The Toyama Prefecture decided on the adoption of a melting treatment system fully capable of minimizing sludge generation, achieving safety by sealing in the heavy metals, and recycling the generated sludge for use as a construction material. The Futakami Sewage Treatment Plant started operating the melting furnace in July 1988. Capacity of the sludge melting furnace is 5.3 ton of dry solids/day. Dewatered sludge is dried in a low temperature dryer until the moisture content is around 20%. Dryer exhaust gas is recycled as carrier gas after the moisture is removed in a moisture removal tower. About 20% of the circulation gas is drained as surplus exhaust and deodorized by combustion in the secondary combustion chamber of the melting furnace. The reflector melting furnace consists of a feeding hopper, primary combustion chamber and secondary combustion chamber. The primary combustion chamber is a conical shape. In the primary combustion chamber, just the necessary caloric value of the dried sludge is incinerated to maintain the temperature at above 1300 C and the rest is completely burned as decomposed gas in the secondary combustion chamber. In this way, double stage combustion in the reflector melting furnace generates less than 150 parts per million of nitrous oxides. Heat from the exhaust gas is collected and utilized as a drying heat source. The exhaust is then cooled to 40-60 C, and SOx and HCl are removed from the gas by the NaOH-rich circulation liquid in the upper absorption chamber. Dust is removed by a wet precipitator. About 170 tons of slag were generated in 1988; some 190 tons of slag are expected in 1989. Leaching tests conducted on the slag at different pHs showed no leaching of harmful components. (Mertz-PTT)
W91-05504

INTRODUCTION OF DEEP OXIC/ANOXIC TANKS AT HENDRIKSDAL SEWAGE TREATMENT PLANT TO INCREASE THE CAPACITY.
Stockholm Water and Wastewater Works (Sweden).
J. Hultgren, I. Mollersten, and L. G. Reinius.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1783-1792, 1991. 11 fig, 7 tab, 1 ref.

Descriptors: *Hendriksdal, *Sweden, *Wastewater facilities, *Wastewater treatment, Aeration, Aerators, Aerobic treatment, Air flow, Anaerobic treatment, Construction methods, Design standards, Dissolved oxygen, Rocks.

The requirements for purification of sewage are tightening in Sweden. At the Henriksdal sewage treatment plant situated in rock, the volume available for of the biological stage of nitrogen removal have to be increased from about 70,000 cubic m today to about 200,000 cubic m in the future. To achieve adequate volumes, the aeration tanks must be deepened from 5 to 12 m. To learn more about aeration at there depths, a pilot plant tank was built during the spring of 1989. The tank is 5 m in diameter, without maximum test depth of 13 m. A full-coverage system of 61 Nopol KKI rubber membrane aerators was installed on the floor. Measurements of the oxygen transfer efficiency were carried out in clean water at 5 m, 7.5 m, 10 m and 12 m. Air flow was measured with a mass flowmeter and the dissolved oxygen was measured partly with four dissolved oxygen probes at different levels and partly with analyses of grab samples. All data were sampled in a computer and were evaluated with the ASCE Non-linear Oxygen Transfer Estimation Program. The results indicated an almost linear relationship between the oxygen transfer efficiency and the aeration depth. For air flows in the interval 1-5 cubic nanometers/hour and diffuser, the efficiency was about 5% per m aeration depth. To achieve the required volume of 205,000 cubic m with 14 aeration tanks, the depth must be 12 m. The existing tanks are 5 m deep and have to be deepened by 7 m. The 14 aeration tanks will be coupled two and two with a total length of 240 m. Each of these coupled lines will be connected with two secondary tanks. In each of the 7 lines the flow to the two sedimentation tanks will be regulated separately over weirs at the end of the aeration tanks. Since the plant must be in operation throughout the entire extension period with the least possible reduction of capacity, the work will be divided into three stages. Total cost for the planned extension of Henriksdal sewage treatment plant is calculated to be around $75-90 million. The extension should be ready in mid-1990. (Mertz-PTT)
W91-05505

ADVANCED WASTEWATER TREATMENT BY MEANS OF DRY BED FILTERS; SEMI-TECHNICAL TEST RESULTS; EXPERIENCES ON A LARGE-TECHNICAL SCALE AND RESULTS.
Hanover Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft und Abfalltechnik.
A. Kraft, and C. R. Seyfried.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1793-1801, 1991. 9 fig, 4 tab, 6 ref.

Descriptors: *Advanced wastewater treatment, *Dry bed filtration, *Filtration, *Wastewater treatment, Biological oxygen demand, Biological treatment, Biological wastewater treatment, Chemical oxygen demand, Filters, Municipal wastewater, Pulp and paper industry, Suspended solids, Trickling filters.

The dry bed filtration process eliminates suspended solids and can be combined with biological activities such as nitrification and reduction of chemical oxygen demand and biological oxygen demand. In the dry bed filtration water treatment system, water is distributed via a sprinkling system over a filter bed surface. The water trickles over the surface of the filter material. Air is sucked or pressed through the filter bed in the direction of the water flow or against the water flow, depending on design. For maximum effectiveness, wastewater should be filtrated as deep as possible into the bed. Multi-bed or dual-bed dry bed filters are most effective. Tests concerning the nitrification performance and simultaneous elimination of suspended solids with a basalt/anthracite filter showed that a dual-media dry bed filter, compared with conventional processes, is extremely efficient. Maximum volumetric degradation performances of 2.0 kg NH4-N/cubic m/day were achieved. Tests carried out at two large technical plants (municipal wastewater treatment plant and paper industry wastewater treatment plant) showed that dry bed filtration is a practical and efficient means of wastewater treatment. (Mertz-PTT)
W91-05506

REVIVAL OF INCINERATION IN THE UK.
AQUA-ENVIRO, Wakefield (England).
P. Lowe, and G. Groeger.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1803-1810, 1991. 7 tab, 4 ref.

Descriptors: *England, *Incineration, *Sludge disposal, *Sludge treatment, *Waste management, *Wastewater treatment, Cost analysis, Environmental protection, Humus sludge, Primary sludge, Sludge, Wastewater facilities.

Incineration of sewage sludge was regarded, in the United Kingdom in the 1970s, as a viable method for the disposal of sludge. Toward the end the that decade the operating costs, compared with those of other treatment methods, were very high and all but four incineration plants were closed down. In 1986, Yorkshire Water contracted for the construction of the first new incinerator in almost a decade. The plant was designed to incinerate 18,000 dry tons/year of sewage sludge comprising 11,500 dry tons of primary sludge and 6,500 dry tons of humus sludge. It had to operate for 8000 hours per year under autogenous conditions and was required to meet current air emission standards. The integrated design approach resulted in competitive operating costs. Competitive costs, together with environmental pressures to control or reduce other disposal routes, such as recycling to agricultural land, landfill and sea disposal, has led to a renewed interest in the incineration process. Early operational experience from the Bradford plant indicates that the two major objectives of no harmful effects on the environment and competitive operating costs can be met with modern, well-designed incineration plants. Plans are in hand to provide two more plants in Yorkshire, and other Water Services are also evaluating the incineration process as part of their overall sludge disposal strategy. (Mertz-PTT)
W91-05507

MEASUREMENT OF OPERATOR TRAINING BENEFITS.
California State Univ., Sacramento. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-05508

APPLICATION OF COARSE-MEDIA SLOW SAND FILTRATION IN AQUACULTURE.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5F.
W91-05509

CAPABILITY OF ON-SITE SEWAGE TREATMENT SYSTEM IN JAPAN: CASE STUDY IN THE TOKYO SUBURB OF NAGAREYAMA CITY.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
J. Nakanishi, M. Ishiwatari, and M. Ichimura.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1835-1844, 1991. 3 fig, 5 tab, 8 ref.

Descriptors: *Japan, *Nagareyama, *On-site wastewater treatment, *Wastewater facilities,

*Wastewater treatment, Case studies, Cost-benefit analysis, Urban areas, Wastewater disposal.

In Japan, the rapid and unsystematic concentration of large populations in metropolitan areas has caused a drastic decrease in surface water quality. At the same time, only 33% of the population is serviced by the existing sewerage system. In areas not served by sewage treatment systems, where half the households use flush toilets gray water is discharged into receiving ditches and streams without any treatment. This wastewater is treated in conventional purification tanks and discharged into surface receiving waters. The other half of the households use nonflush toilets--privy pits. Night soil from these houses is collected and transported by vacuum trucks to be treated at facilities. Technology for the on-site treatment of raw sewage from households with few members has developed very rapidly, and such installations have been approved since 1985. A typical commercial treatment unit for a family of five measures 2.3 m long by 1.2 m wide and 1.5 m deep, about the size of a small car. The capability of an on-site sewage treatment system was examined in Nagareyama, a suburb of metropolitan Tokyo, with the multi-objective optimization method. The total cost, local expense, drinking water quality, stream water quality and speed of sewerage service were considered and evaluated another relative weight by interviews with 44 citizens. On-site treatment systems appear to be more economical in many districts, when compared with regional sewerage. No sewer pipes are needed and on-site plants can be mass-produced. In the optimal sewerage plan, about half of the planning area was concluded to be suitable for on-site treatment systems. (Mertz-PTT)
W91-05511

DISSOLVED OXYGEN IN SMALL WASTEWATER COLLECTION SYSTEMS.
Technical Univ. of Lisbon (Portugal). Dept. of Civil Engineering.
J. Saldanha Matos, and E. Ribeiro de Sousa.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1845-1851, 1991. 3 fig, 2 tab, 7 ref.

Descriptors: *Biological wastewater treatment, *Dissolved oxygen, *Flow velocity, *Sewage bacteria, *Sewers, *Wastewater treatment, Aeration, Biological treatment, Flow characteristics, Oxygen balance, Slime, Wastewater management.

The oxygen balance in a stream of sewage is important with respect to the control of septicity which is frequently associated with the generation of sulfide, and with respect to the degree of biological oxidation that usually occurs within sewerage systems. To predict the oxygen balance in sewers, reaeration and dissolved consumption, both within the stream and within the biological slime layer on the pipe wall, must be computed, with special emphasis given to the slime layer. Fours sewers in a small municipal sewer system were studied: one located near the upstream end of the wastewater system with a mild slope; another also located at the upstream end, but with a steep slope; and two sewers located near the downstream end of the system with flat slopes. A comparison of the experimental results concerning the activity of the slime layer, as calculated by the Pomeroy and Parkhusrt equation, did not lead to good agreement. Under low flow conditions and high dissolved oxygen concentrations, a significant correlation was found between velocity and dissolved oxygen consumption by the slime layer. No correlation was found between dissolved oxygen concentration within the stream and dissolved oxygen utilization by the slime layer. (Mertz-PTT)
W91-05512

WASTEWATER TREATMENT BY A SUBMERGED CONTACT MEDIA PROCESS USING NET PLATES.
Gifu Prefectural Inst. of Public Health (Japan). Dept. of Physics and Chemistry.
T. Nambu, K. Kawarura, and M. Kaneko.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1853-1862, 1991. 11 fig, 2 tab, 7 ref.

Descriptors: *Activated sludge process, *Biofilm reactors, *Biological oxygen demand, *Biological wastewater treatment, *Wastewater treatment, Biotechnology, Comparison studies, Microorganisms, Nitrogen removal, Retention time, Temperature.

The activated sludge process requires more complicated maintenance and operation, and produces more excess sludge, than other biological wastewater treatment processes. Small communities that have difficulties in getting skilled engineers are not willing to adopt this process in their own wastewater management programs. It is believed that the biological wastewater treatment processes using attached microorganisms are suitable for application in such small communities. Wastewater treatment using a series of bioreactors with submerged net plates on which microbial growths can develop, was studied to evaluate its treatment performance and to find suitable operational conditions for sufficient biological oxygen demand and nitrogen removal. A comprehensive experimental study was carried out using a bench-scale plant which treated artificial wastewater, and a pilot-scale plant which treated municipal wastewater. This process worked well for the wastewater with higher pollutant loads compared to the conventional activated sludge process. Wastewater containing 200 mg biological oxygen demand/L was reduced to 20 mg biological oxygen demand/L at the high biological oxygen demand loading of 1.94 kg/cu m/day and a retention time of less than 5 hours. Nitrogen removal can be explained by an index defined as the product of the water temperature and the retention time. When the ratio, in flow rate of recycled water to influent was 4, and the index was more than 400, a nitrogen removal of more than 80% was obtained. (Mertz-PTT)
W91-05513

PILOT PLANT STUDIES ON TANNERY WASTE WATER TREATMENT WITH THE OBJECTIVE TO REDUCE SLUDGE PRODUCTION.
Venice Univ. (Italy). Dept. of Environmental Science.
L. Szpyrkowicz, S. Rigoni-Stern, and F. Zilio Grandi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1863-1871, 1991. 3 fig, 6 tab, 13 ref.

Descriptors: *Italy, *Physicochemical treatment, *Pilot plants, *Tannery wastes, *Wastewater treatment, Biological treatment, Chemical treatment, Industrial wastewater, Sludge excess, Sulfides, Wastewater composition.

With the demand being placed on industries to meet rigid Italian standard requirements for effluents, problems related to the treatment of tannery wastewaters appear to be particularly complex. The presence of a high sulfide content, together with a very high organics and nitrogen load, requires a very effective treatment for tannery wastewater. However, this treatment often produces a large quantity of troublesome sludges. In an effort to reduce the quantity of sludge produced during the treatment of chrome tannery wastewaters, the modified Ludzack-Ettinger process for high nitrogen content wastewaters was tested, without the chemical-physical pretreatment normally adopted to eliminate the compounds potentially inhibitory for biological processes. In a full-scale treatment plant, wastewaters flow into an aerated equalization tank with a 22-hour retention time, where sulfides are oxidized by air in the presence of $MnSO_4$ as catalyst. Wastewaters then undergo a chemical-physical treatment with aluminum salts, lime and an anionic poly-electrolyte. In the pilot plant used, basic operational parameters of the biological section of the full-scale plants were the same, except for a slight variation of hour residence time. The main difference between the full-scale and the pilot plant was the lack of equalization or a chemical-physical phase. In the experiment, the pilot plant was fed with the same raw wastewaters that arrive at the full-scale treatment plant. Results obtained in the pilot plant during four runs differing in wastewater flow and strength, and in mixed-liquor suspended solids recycling ratio, demonstrated the lack of inhibition of denitrification and nitrification by the high content of sulfides and chromium. In comparison with traditional tannery wastewater treatment, a 60% reduction of the sludge to be wasted, and the improvement of final effluent quality were achieved. The mean overall rate of chemical oxygen demand removal was 0.38 mg chemical oxygen demand/mg mixed-liquor suspended solids/day and nitrogen removal was 0.125 mg N/mg mixed-liquor suspended solids/day. (Mertz-PTT)
W91-05514

FEASIBILITY EVALUATION OF A NOVEL METHOD FOR DESTRUCTION OF ORGANICS.
Khudenko Engineering, Atlanta, GA.
B. M. Khudenko.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1873-1881, 1991. 4 fig, 1 tab, 11 ref.

Descriptors: *Electrochemistry, *Hazardous wastes, *Industrial wastes, *Physicochemical treatment, *Waste treatment, *Wastewater treatment, Aluminum, Hydrogen ion concentration, Iron, Organic wastes, Oxidation-reduction potential.

Many industries generate aqueous wastes bearing hazardous and/or poorly degradable organics, such as solvents, complexing agents, dyes, antiseptic materials, still bottoms and other process tails. An array of chemical and physical-chemical processes exists for destruction of such organics. Of all these methods, only electrochemical processes can effect both oxidation and reduction reactions in a single apparatus. Major disadvantages of the existing electrochemical processes include high energy use and complex and expensive equipment. The feasibility of an alternative process that is free from disadvantages of current processes was examined. The method, called cementation induced oxidation-reduction of organics, belongs to the class of electroless electrochemical processes, and makes use of a sufficiently electronegative sacrificial metal, such as iron or aluminum, a salt of a sufficiently electropositive metal, such as copper, and reagents for pH control. The oxidation-reduction of organics is induced as a parallel reaction to the cemetation process. Based on theoretical analysis and preliminary experimental evaluations, the technical feasibility of the new method has been shown. In particular, the chemical transformation of dissolved organics, such as dyes, and the separation of emulsified oil and grease have been demonstrated. The process rate and efficiency are substantially higher than those of other processes. The major factors essential for metal cementation, particularly the presence of a sacrificial metal and noble metal ions, and an acidic medium, are also operable in the cementation induced oxidation-reduction of organics. When at least one of these factors is missing, the process efficiency and rate decline dramatically. The sludges produced in the cementation induced processes appear to be more dense than those generated in the coagulation processes, and are more easily filterable. The estimated process economics compares favorably to that of competing processes. (Mertz-PTT)
W91-05515

BIOLOGICAL TREATMENT OF COKE-PLANT WASTEWATER FOR COD AND NH3-N REMOVAL.
Tsinghua Univ., Beijing (China). Dept. of Environmental Engineering.
W. Yibo, Z. Min, and Q. Yi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1883-1892, 1991. 8 fig, 8 tab, 19 ref.

Descriptors: *Ammonia, *Biological wastewater treatment, *Chemical oxygen demand, *Coke plant wastewater, *Wastewater treatment, Activated sludge, Cyanide, Nitrogen compounds, Phenols, Steam stripping, Sulfur.

Coke plant wastewaters are generally a composite of waste ammonia liquor, light oil plant wastewater and several lesser streams, all generated in the by-product area of a coke plant. The contaminants present in these wastewaters include: ammonia, cyanide, thiocyanate, phenolics and

other organic substances, such as mono-cyclic and poly-cyclic nitrogen-containing aromatics, oxygen-containing and sulfur-containing heterocyclics and polynuclear aromatic hydrocarbons. Treatment of coke plant wastewater involes solvent extraction for the removal of phenolics and other organics, and steam stripping for the reduction of ammonia and other dissolved gases, followed by a biological treatment unit. Because of the presence of refractory and biologically inhibitory organics in coke plant wastewaters, a conventional activated sludge system is not efficient in removing chemical oxygen demand, although it is acceptable in phenol and biological oxygen demand removal. For removing chemical oxygen demand and NH3-N from high strength coke plant wastewaters, studies were conducted on a laboratory scale, using a continuous flow system in which anaerobic, anoxic and oxic units were included. Results showed that the effluent chemical oxygen demand of anaerobic, anoxic and oxic systems could be less than 78 mg/L and NH3-N could be less than 4.7 mg/L when the influent chemical oxygen demand was higher than 1200 mg/L and NH3-H was higher than 240 mg/L at a total hour residence time of 36 hours. Moreover, the total wastewater nitrogen was reduced by 49%. It is concluded that anaerobic, anoxic and oxic system is efficient for coke plant wastewater treatment; the anaerobic process has played a very important role in the system. (Mertz-PTT)
W91-05516

FERRITE PROCESS; HEAVY METAL IONS TREATMENT SYSTEM.
Tokyo Inst. of Tech. (Japan). Dept. of Chemistry.
Y. Tamaura, T. Katsura, S. Rojarayanont, T. Yoshida, and H. Abe.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1893-1900, 1991. 5 fig, 3 tab, 13 ref.

Descriptors: *Cations, *Chemical treatment, *Ferrite process, *Heavy metals, *Iron compounds, *Wastewater treatment, Hydrogen ion concentration, Japan, Laboratory methods, Laboratory wastes, Metal-finishing wastes, Mine wastes.

The Ferrite process was first adopted as a treatment for the laboratory wastewaters containing heavy metal ions from the Tokyo Institute of Technology, in 1979. In the Ferrite Process, the heavy metal ions are incorporated into the lattice points of the ferrites in the course of the formation of spinel structure is a oxidation of the Fe(II) ions. The ferrite formation reaction proceeds in two paths depending on the reaction pH: (1) the green rust path (pH 7-10), and (2) the gamma-FeO(OH) path (pH 10.5-11). The mole ratio of the heavy metal ions incorporated into the lattice points to the total Fe in the ferrites depends on the reaction pH and the mole ratio of the heavy metal ions in the reaction solution, and to the Fe(II) ions added to the reaction solution. Ferrite Process is now practically adopted to the treatment of the laboratory wastewaters at the universities and the institutes in Japan, to the treatment of the plating wastewaters, and to the treatment of branching mine drainage waters. Since the ferrite sludge has a strong magnetic property, it is reused as a useful magnetic material. (Author's abstract)
W91-05517

PRETREATMENT OF YEAST INDUSTRY WASTEWATER IN AN AERATED BALANCING TANK AND ITS EFFECT ON THE MUNICIPAL TREATMENT PLANT PERFORMANCE.
Aquateam-Norwegian Water Technology Centre of Oslo (Norway).
B. Rusten, and K. Sandberg.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1901-1908, 1991. 5 fig, 5 tab, 6 ref.

Descriptors: *Food-processing wastes, *Industrial wastes, *Pretreatment of wastewater, *Wastewater treatment, *Yeasts, Aeration, Biological wastewater treatment, Chemical wastewater treatment, Laboratory tests, Norway, Residence time.

Historically, untreated wastewater from the Idun yeast plant in Oslo, Norway was discharged to the City of Oslo's municipal wastewater treatment plant at Bekkelaget. The municipal treatment plant is a chemical/biological plant with pre-precipitation. Organic shock loads from the yeast plant caused severe operational problems and unacceptable effluent qualities at the chemical/biological wastewater treatment plant serving the City of Oslo. To alleviate these problems a pretreatment concept for the yeast wastewater, based on an aerated balancing tank without following solids separation, was proposed. Laboratory tests with aeration of yeast wastewater at hydraulic residence times of 0.5 to 2.3 days showed 25 to 67% removal of soluble chemical oxygen demand. Jar-tests indicated that with proper balancing, yeast wastewater aerated for at least 0.8 days would have a very limited influence on the pre-precipitation process at the municipal treatment plant. Based on this information, a full-scale aerated balancing tank was constructed. After pretreatment of the yeast wastewater was introduced, data from the municipal treatment plant showed very low and stable effluent concentrations. (Mertz-PTT)
W91-05518

ANAEROBIC-AEROBIC TREATMENT OF ORGANIC HIGH-STRENGTH INDUSTRIAL WASTE WATER.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasservorsorge.
R. Haberl, K. Atanasoff, and R. Braun.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1909-1918, 1991. 7 fig,, 7 tab, 9 ref.

Descriptors: *Aerobic treatment, *Anaerobic digestion, *Denitrification, *Industrial wastewater, *Pretreatment of wastewater, *Wastewater treatment, Austria, Chemical oxygen demand, Corn, Food-processing wastes, Nitrogen, Wood wastes.

A research project funded by the Austrian Ministry of Agriculture and Forestry examined a number of high strength organic industrial wastewater that were treated anaerobic-aerobically. Sewages from maize starch production and from rendering plants were taken as examples to illustrate the influence of anaerobic pretreatment on aerobic subsequent stage. The sewage of the fiberboard industry served as example for testing different anaerobic reactions and some ways of neutralization. For most of the sewages, the anaerobic-aerobic treatment turned out to be possible, although occasional technical problems were observed. Such problems occurred in the final aerobic stage in connection with wastes with a high content of N. They could be solved by a predenitrification stage. Fiberboard sewage was taken as an example for wastes containing persistent substances; different anaerobic processes were tested, it turned out that a two-stage anaerobic treatment was necessary to stabilize the process. In many cases the anaerobic-aerobic process proved to be very economical. In a detailed calculation of costs concerning wastes from the fiberboard industry, the economy of the anaerobic-aerobic treatment was compared with that of the aerobic treatment. From the economical point of view, the anaerobic-aerobic process must be preferred to the aerobic one, but only with chemical oxygen demand-load $>$ 4 kg/cubic m/cu day, chemical oxygen demand-reduction $>$ 70% and with the use of Ca(OH)2 for neutralization in the anaerobic pretreatment. (Mertz-PTT)
W91-05519

ANAEROBIC (UASB) TREATMENT OF PULP (CTMP) WASTEWATER AND THE TOXICITY ON GRANULES.
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
A. Kudo, K. Kennedy, and E. Andras.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1919-1928, 1991. 7 fig, 2 tab, 7 ref.

Descriptors: *Anaerobic digestion, *Pulp and paper industry, *Pulp wastes, *Toxicity, *Wastewater reactors, *Wastewater treatment, Biogas, Chemical oxygen demand, Industrial wastewater, Methane bacteria, Sludge bed, Sludge digestion, Suspended solids.

A chemi-thermomechanical pulp (CTMP) effluent was treated by upflow anaerobic sludge bed (UASB) reactors. The purpose of the 254 day experiment was to evaluate the acclimatization process for two types of anaerobic granules to chemi-thermomechanical pulp wastewater. One type was an acetic acid enriched culture composed mainly of methanogenic bacteria (reactor I) and the other was a mixed anaerobic culture containing both methanogenic and acidogenic bacteria (reactor II). Initially, the reactors were maintained on synthetic feed with acetic acid (reactor I) or sucrose (reactor II) as the carbon source. In order to acclimatize the granules to the wastewaters, chemi-thermomechanical pulp wastewater was introduced in 3 stages (10, 50, and 100 %). The wastewater contained 8200 mg/L chemical oxygen demand, 30-40% of which was non-biodegradable. Both reactors were operated at a specific loading rate of 0.16 g chemical oxygen demand/g volatile suspended solids/day throughout the experiment. Supplementary batch tests using serum bottles were conducted to evaluate toxicity of the chemi-thermomechanical pulp wastewater and two known toxic compounds, pentachlorophenol and mercuric chloride, on mixed anaerobic culture granules. Reactor II acclimatized to the chemi-thermomechanical pulp wastewater better than reactor I. At 50% chemi-thermomechanical pulp wastewater, a chemical oxygen demand removal rate of 80% was attained for reactor II, while reactor I removed only 55% of the influent chemical oxygen demand. An unexpected discovery was that the granules from both reactors were completely inhibited 2 weeks after the completion of the 254 day experiment. The results of batch tests showed a dramatic reduction in granule biogas production after exposure both to starvation and to toxicants at levels higher than a certain threshold concentration. The toxicity of 100% chemi-thermomechanical pulp was equivalent to 7 parts per million of pentachlorophenol and 25 parts per million of mercuric chloride. (Mertz-PTT)
W91-05520

PREDICTION OF OXYGEN TRANSFER RATES FROM SIMPLE MEASUREMENTS OF BUBBLE CHARACTERISTICS.
Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Wasserversorgung, Abwasserbeseitigung und Raumplanung.
H. J. Popel, and M. Wagner.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1941-1950, 1991. 4 fig, 2 tab, 11 ref.

Descriptors: *Aeration, *Analytical techniques, *Bubbles, *Dissolved oxygen, *Oxygen transfer, *Wastewater treatment, *Water analysis, Absorption, Instationary absorption method, Oxygen, Water measurement, Water quality.

The oxygen transfer rate in water is generally determined by the instationary absorption method, a precise but rather time consuming and tedious method. Moreover, large quantities of sodium sulfite and water are used in practice when testing aeration equipment in larger tanks. Therefore, a model is proposed by which the oxygen transfer rate can be calculated on the basis of simple and rapid measurements of the air bubble size and its distribution and of the total air content in the water applying a recently developed technique. The accuracy of this method is checked by the absorption method and can be rated as reasonable (0 to 13% deviation). Greater accuracy is obtained at smaller bubbles ($<$3 mm) and improvements in this respect are proposed. The proposed method of calculating the oxygen transfer rate from air bubble measurements is considered as a potential improvement of the usual absorption method. Due to its still lower accuracy it can be used at present only in conjunction with the instationary absorption method, reducing its chemical and water consumption. (Author's abstract)
W91-05522

BASIC STUDY OF THE EFFICIENCY OF SPIRAL FLOW AERATION.
NGK Insulators Ltd., Nagoya (Japan).
T. Kasakura, Y. Tomita, K. Matsubara, and A. Kubo.
Water Science and Technology WSTED4, Vol.

23, No. 10/2, p 1951-1960, 1991. 4 fig, 3 tab, 5 ref.

Descriptors: *Aeration, *Aerators, *Energy use efficiency, *Oxygen transfer, *Spiral flow aeration, *Wastewater treatment, Aeration tanks, Bubbles, Diffusers, Energy conservation, Performance evaluation, Regression analysis.

Spiral flow aeration is the most commonly used aeration system in sewage treatment at this time. For energy saving purposes, it is important to establish how spiral flow aeration could be done more efficiently. The oxygen transfer efficiency of spiral flow aeration is affected by many factors, such as the shape of aeration tank, the type of diffuser, and the air flow rate. The relationship between these factors and the efficiency of aeration was examined. It was found that these factors were restricted by certain independent variables, for example, depth of the diffuser and pressure at that depth. The relationship between these variables and the efficiency of aeration based on data from full scale experiments on spiral flow aeration using porous ceramic diffusers was analyzed quantitatively. Experimental data were regression analyzed by adding the factor of bubbling area to get quantitative relationships between the oxygen transfer efficiency at any operating condition by the postulation of each factor. Regression equations showed that the efficiency of spiral the aeration would be higher with a reduction of the air feed rate per tank volume and an increase of the total bubbling area of the diffusers. Other variables did not have as important an effect on efficiency. (Mertz-PTT)
W91-05523

SEWAGE SLUDGE COMPOSTING PROCESS BY STATIC PILE METHOD.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
For primary bibliographic entry see Field 5E.
W91-05526

PILOT PLANT TEST OF ELECTRON-BEAM DISINFECTED SLUDGE COMPOSTING.
Japan Atomic Energy Research Inst., Takasaki. Takasaki Radiation Chemistry Research Establishment.
S. Hashimoto, K. Nishimura, H. Iwabu, and K. Shinabe.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1991-1999, 1991. 8 fig, 6 tab, 8 ref.

Descriptors: *Composting, *Disinfection, *Ionization, *Radiation, *Sludge treatment, *Wastewater treatment, Aeration, Cost analysis, Fermenter, Sludge, Sludge utilization, Temperature.

It is well known that land application of sewage sludge benefits plant growth, crop production and soil conditioning. One problem is contamination by pathogenic microorganisms. Ionizing radiation is effective for the disinfection of pathogenic bacteria in sludge. A pilot plant was built to gather information on scale-up factors associated with electron-beam disinfection of sludge for composting. A Cockcroft-Walton type of electron accelerator was used. Maximum accelerating voltage was 2 megavolts and beam current was 30 milliamps. Because penetration of the electron beam was narrow, it was necessary to spread the sludge cake in a thin layer on a conveyer. Raw sludge pumped through a flat nozzle applied a thin layer of sludge on the conveyer. The width of the nozzle was 20 cm and sludge thickness was adjustable. The composting plant consisted of a mixer, a granulating machine, a fermenter with three screw-type mixing blades, and the conveyer system. Efficient composting was realized by controlling fermentation temperature, by controlling air flow rate, and by frequent mixing in the fermenter. An economic feasibility study based on results from the pilot plant showed that capital costs and treatment costs for the process could be lower than those seen in conventional composting setups, if the treatment capacity of the plant exceeded 50 ton/day. (Mertz-PTT)
W91-05527

COST OPTIMIZATION OF SEWAGE SLUDGE FILTERPRESSING.
Istituto di Ricerca sulle Acque, Rome (Italy).
G. Mininni, L. Spinosa, and V. Lotito.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2001-2009, 1991. 3 fig, 6 tab, 10 ref.

Descriptors: *Cost analysis, *Pressure filtration, *Sludge dewatering, *Sludge treatment, *Wastewater treatment, Costs, Filtration, Japan, Sludge cake, Sludge disposal, Wastewater disposal.

The effectiveness and cost of sewage sludge treatment and disposal are strongly affected by sludge volume and, consequently, by its solids concentration. Therefore, mechanical dewatering is a very important operation that is almost always utilized in sludge processing. Several types of equipment can be used for sewage sludge dewatering, but cakes with solids concentration higher than 30% can be easily produced only by pressure filtration. As a result, a self-sustaining combustion, and easier landfilling operation and a cheaper disposal cost can be obtained. Models of filterpressing and chemical conditioning allow the dewatering operation to be simulated and then optimized with regard to total cost. The optimizing procedure was applied to a dewatering plant serving 100,000 inhabitants with a unit production of 70 g/day dry solids; initial sludge concentration and specific resistance to filtration were considered as parametric values. Moreover, disposal unit costs of 25,000 and 50,000 Italian lira/ton and total operating times of 8 and 16 hours were considered. The optimal operating conditions were determined as those minimizing the total cost. The best results were obtained with sludges of better quality, for example, higher initial solids concentration and lower specific resistance to filtration. Total costs varied from 604 to 2004 million Italina lira/year with an incidence of operating costs varying over the range of 18-45%. Due to the strong influence of amortization and disposal costs, the optimal operating conditions result, in practice, in those minimizing such costs. (Mertz-PTT)
W91-05528

ESTIMATION OF ENERGY SAVING FOR MELTING PROCESS ON SEWAGE SLUDGE.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
For primary bibliographic entry see Field 5E.
W91-05529

CHARACTERISTICS OF MELTING PROCESS FOR SEWAGE SLUDGE.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
For primary bibliographic entry see Field 5E.
W91-05530

SLUDGE MELTING PROCESS WITH HAZARDOUS ASBESTOS WASTES.
Kyoto Univ. (Japan). Environment Preservation Center.
For primary bibliographic entry see Field 5E.
W91-05531

INTERNATIONAL PERSPECTIVE ON WATER RESOURCES MANAGEMENT AND WASTEWATER REUSE--APPROPRIATE TECHNOLOGIES.
International Bank for Reconstruction and Development, Washington, DC. Infrastructure and Urban Development Dept.
For primary bibliographic entry see Field 3C.
W91-05532

ROLE OF WASTEWATER RECLAMATION AND REUSE IN THE USA.
California Univ., Davis. Dept. of Civil Engineering.
T. Asano, and G. Tchobanoglous.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2049-2059, 1991. 1 fig, 4 tab, 9 ref.

Descriptors: *Groundwater recharge, *Industrial water, *Irrigation water, *Reclaimed water, *United States, *Wastewater treatment, *Water reuse, Arid lands, Humid areas, Wastewater management, Wastewater utilization, Water supply.

Pockets of inadequate water supply represent a serious contemporary concern for the U.S. water supply industry. Several factors have contributed to the problem. Contamination has forced the closure of many well fields across the country. Droughts have exacerbated water problems in some areas. Long-term trends in water demand and the availability of new water supplies have given impetus for wastewater reclamation and reuse. Although the uses of reclaimed wastewater are relatively small at present, reclaimed wastewater has potential to be a permanent component in an integrated water supply system. Agricultural and landscape irrigation offer significant opportunities for wastewater reuse. The second potential use of reclaimed municipal wastewater is industry, primarily for cooling and process needs. The third potential reuse application is groundwater recharge with reclaimed wastewater, either via spreading basins or direct injection. A fourth use is characterized as miscellaneous subpotable uses, such as for recreational lakes, aquaculture, and toilet flushing in buildings. According to the only comprehensive survey available on existing wastewater reclamation and reuse projects, over 535 wastewater reuse projects were reported in the U.S. As with California, most of the wastewater reuse sites in the U.S. have been located in the arid and semi-arid western and southwestern states. However, an increasing number of wastewater reuse projects are being implemented in the humid regions such as Florida and South Carolina. (Mertz-PTT)
W91-05533

RECENT ADVANCES IN WATER REUSE RESEARCH IN SOUTH AFRICA.
Water Research Commission, Pretoria (South Africa).
P. E. Odendaal.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2061-2071, 1991. 3 tab, 50 ref.

Descriptors: *Foreign research, *Reclaimed water, *South Africa, *Wastewater treatment, *Water reuse, *Water use, Activated carbon, Desalination, Industrial water, Powerplants, Research, Reverse osmosis, Wastewater utilization.

Due to limited water resources, water reuse is pursued as a major component of an overall strategy to optimize water use in South Africa. Progress in South African water reuse research, mainly since 1985, was examined. In the field of potable reuse research, epidemiological studies have been conducted. Activated carbon, the microbiology of reclaimed water bioassaying, and reverse osmosis are being studied. Direct application of purified sewage effluents is being used for agriculture and industry. Indirect reuse is steadily increasing and research that traditionally addressed direct potable reuse is becoming of equal relevance to indirect reuse. In addition, research becomes necessary on problems that relate specifically to indirect reuse, such as: treatment of algal waters; variation of raw water quality; upgrading of sewage effluent quality; organohalogens; and salination problems. Recent advances in research on internal water reuse by industry focuses on membranes and salt removal technology. Reused wastewater has been applied to textile dyehouses, scouring, bleaching and mercerising processes; bottle washing; wool scouring; water works wash water; and power station cooling. (Author's abstract)
W91-05534

HEALTH GUIDELINES AND STANDARDS FOR WASTEWATER REUSE IN AGRICULTURE: HISTORICAL PERSPECTIVES.
Hebrew Univ. of Jerusalem (Israel). Div. of Environmental Sciences.
H. I. Shuval.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2073-2080, 1991. 3 tab, 14 ref.

Descriptors: *Agricultural water, *Irrigation water, *Public health, *Reclaimed water, *Wastewater treatment, *Water quality standards, *Water reuse, Coliforms, Health aspects, Helminths, History, Vegetables, Wastewater utilization.

Although wastewater reuse has been practiced for well over 100 years as an effective combined strategy for water conservation and water pollution prevention, health regulations in the form of guidelines and standards have developed erratically under the influence of varying historical forces and social trends. In the earliest periods there was little or no regulation. Early in the 20th century, with the growing awareness and fear of environmental transmission of communicable diseases, the pendulum swung in the direction of extremely severe, and often unenforceable, health regulation that lacked a firm epidemiological basis. Recent research studies and policy reviews sponsored by the World Band and the World Health Organization have provided a sound scientific basis for re-evaluating the health risks associated with wastewater reuse and technological and policy guidelines for their control. This more rational and realistic approach based on credible epidemiological evidence has led to the promulgation by the World Health Organization of new health guidelines allowing for unrestricted agricultural irrigation of all crops including vegetables eaten raw, with an effluent standard of 1 or less helminths/L and a mean of 1000 fecal coliform/100 ml. (Author's abstract)
W91-05535

ROLE OF WASTEWATER REUSE IN WATER RESOURCES MANAGEMENT IN ISRAEL.
Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).
For primary bibliographic entry see Field 3C.
W91-05536

ASSESSING POTENTIAL HEALTH RISKS FROM VIRUSES AND PARASITES IN RECLAIMED WATER IN ARIZONA AND FLORIDA, USA.
University of South Florida, Tampa. Dept. of Environmental and Occupational Health.
J. B. Rose, and C. P. Gerba.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2091-2098, 1991. 7 tab, 18 ref.

Descriptors: *Arizona, *Florida, *Public health, *Reclaimed water, *Risk assessment, *Water reuse, Activated sludge, Chlorination, Disinfection, Filtration, Giardia, Irrigation water, Parasites, Viruses, Wastewater treatment, Water quality standards.

Wastewater reuse has been mandated in both the states of Arizona and Florida. In Arizona, standards have been set for enteric virus and Giardia levels to maintain a specified effluent quality depending on the reuse; in Florida, specified treatment control has been implemented. Data on virus levels in treated wastewaters have been generated in both states. Average virus levels ranged from 13-130 plaque forming units/100 L after secondary treatment, while with the addition of filtration, levels were reduced to averages between 0.13 to 1.25 plaque forming units/100 L. Giardia cyst levels also dropped by 100-fold after filtration averaging 0.32/40 L. Using a probability of infection model, risk infection from 100 ml accidental ingestion ranged from approximately .002 to .0002 for the levels of viruses and protozoa found in chlorinated secondary effluent and the risk was reduced to .0002 to .000002 with filtration and disinfection following activated sludge treatment. It appears that well operated treatment plants with secondary treatment, filtration and disinfection produce a quality of reclaimed water that can be used for non-restricted irrigation while maintaining an adequate margin of safety by limiting the population exposed to these waters containing low levels of pathogens. The results of these studies in both states demonstrate that, in order to achieve an effluent quality for unrestricted irrigation, filtration is needed in addition to secondary treatment. (Mertz-PTT)
W91-05537

USE OF RECLAIMED WASTEWATER FOR ORNAMENTAL AND RECREATIONAL PURPOSES.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
For primary bibliographic entry see Field 3C.
W91-05539

EFFLUENTS QUALITY ALONG A MULTIPLE-STAGE WASTEWATER RECLAMATION SYSTEM FOR AGRICULTURAL REUSE.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 3C.
W91-05540

WASTEWATER REUSE FOR IRRIGATION IN THE NEAR EAST REGION.
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
For primary bibliographic entry see Field 3C.
W91-05541

WATER SAVING AND WASTEWATER REUSE AND RECYCLE IN CHINA.
Beijing Municipal Research Inst. of Environmental Protection (China).
Z. Zhongxiang, and Q. Yi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2135-2140, 1991. 1 tab, 7 ref.

Descriptors: *China, *Developing countries, *Public policy, *Reclaimed water, *Water conservation, *Water reuse, Industrial wastewater, Industrial water, Municipal wastewater, Wastewater treatment, Wastewater utilization, Water consumption, Water resources management, Water supply.

With the development of industrial economy and urban construction and the increase of population, the water demand of cities, industries and agriculture has been rapidly increasing in China. In addition, water pollution is a very serious problem in China. Based on information provided by the national Environmental Protection Agency, the total annual amount of wastewater in 1987 was 34.9 billion tons, including 26.4 billion tons of industrial wastewater. About 74% of the wastewater was untreated and directly discharged into rivers, lakes and seas. The prevention of water pollution and economizing water resources has been declared a national policy by the Chinese government. Many effective measures have been taken to economize water use in industry. Municipal wastewater is treated and successfully reused for different purposes in the northern region of China. Compared with developed counties, the water consumption per unit industrial products in China is rather high, so an effort is being made to develop water and wastewater reuse and recycle systems that will cut down on water consumption. Such activities include: recycling cooling water; reuse and recycle wastewater; and implement cascade reuse systems (multi-purpose reuse systems) for water and wastewater. Some production processes can be modified to reduce water consumption, such as: develop vaporizing cooling systems for blast furnaces, converters, and other furnaces; apply air-cooling processes; and develop new cleaning processes. Tightening up the management of water resources and water users is another important measure for solving water shortage problems. Some cities in Northern China have made comprehensive plans for reuse of treated municipal wastewater as a secondary water resource. (Mertz-PTT)
W91-05542

WASTEWATER REUSE CASE STUDIES IN THE MIDDLE EAST.
Acer Consultants Ltd., London (England).
For primary bibliographic entry see Field 3C.
W91-05543

WASTEWATER DISPOSAL BY SUB-SURFACE TRICKLE IRRIGATION.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 3C.
W91-05544

PUBLIC ATTITUDE TOWARDS WATER AND WATER REUSE.
Qatar Univ., Doha. Faculty of Engineering.
For primary bibliographic entry see Field 6B.
W91-05546

WATER QUALITY FOR POTABLE REUSE.
Denver Water Dept., CO.
W. C. Lauer.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2172-2180, 1991. 5 fig, 2 tab, 19 ref.

Descriptors: *Potable water, *Reclaimed water, *Secondary wastewater treatment, *Wastewater treatment, *Water quality, *Water reuse, Colorado, Cost analysis, Health aspects, Wastewater utilization, Water pollution, Water quality control.

Denver's Potable Water Reuse Demonstration Project is designed to examine the feasibility of converting secondary treated wastewater to potable water quality. A 1.0 million gallons/day treatment plant began operation in 1985 and during the first three years many processes were evaluated. Data from the evaluation period was used to select the optimum treatment sequence which is now being used to produce samples from the two-year animal feeding health effects study now underway. The Reuse Demonstration Plant health effects treatment processes were selected to remove all contaminants present in unchlorinated secondary wastewater effluent. The plant is designed to produce water that satisfies all drinking water regulations and compares with Denver's high quality drinking water. The selected processes were tested to verify their ability to remove high concentrations of a variety of contaminants not routinely found in the plant influent. These tests showed an extremely high level of protection against a potential pollutant. Operation in the current configuration will continue until early 1991 during which time comprehensive analytical studies will further define the water quality in relation to existing standards and Denver's current potable supply. A decision concerning the full-scale implementation of direct potable reuse will follow extensive analysis of the test results and in-depth economic evaluation. (Mertz-PTT)
W91-05547

STUDY OF RECLAMATION OF SEWAGE FOR INDUSTRIAL WATERS.
National Univ. of Singapore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3E.
W91-05548

TRENDS AND PROBLEMS OF WASTEWATER REUSE SYSTEMS IN BUILDINGS.
Tokyo Inst. of Tech. (Japan).
F. Kiya, and H. Aya.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2189-2197, 1991. 5 fig, 5 tab, 6 ref.

Descriptors: *Impaired water use, *Japan, *Water resources management, *Water reuse, *Water use, Public policy, Reclaimed water, Surveys, Wastewater treatment, Wastewater utilization, Water consumption, Water resources, Water supply.

The National Land Agency published a detailed report on the current status of water resources and water consumption in Japan. The agency in concerned about decreasing annual rainfall and droughts in recent winter seasons. Yet, the demand for water is increasing gradually in active urban areas, owing to rapid changes of lifestyle and the concentration of economic activities. To solve the shortage of available water source, the national government and local authorities have introduced the policy to make use of alternative water sources such as reuse of wastewater and utilization of rainwater in large buildings. Details of the practice of wastewater reuse systems in buildings and survey results on the performance of recycling systems installed in large buildings is examined. The investigation suggests that most of reclamation plants perform very well in quality but not well in

quantity. There has never been any serious claim from users nor any hygiene trouble in several years of use. But the full capacity of plants was not usually utilized as designed. The very small demand at weekends and holidays creates operational problems of biological treatment plants and raises cost of reclaimed water. Individual building wastewater reuse is not efficient enough to solve the shortage of water resources. However, it sill remains a very important means to deal with urban problems. It will lessen excess loading on existing sanitary sewers and interceptors and will reduce pollutants discharged from a sewage plant. (Mertz-PTT)
W91-05549

INVESTIGATION ON WASTEWATER REUSE ON PASSENGER AIRCRAFT.
Technische Univ. Hamburg-Harburg (Germany, F.R.).
I. Sekoulov, A. Figueroa, and J. Oles.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2199-2208, 1991. 5 fig, 6 tab, 16 ref.

Descriptors: *Aircraft, *Impaired water use, *Reclaimed water, *Toilets, *Water conservation, *Water reuse, Electrodialysis, Filtration, Membrane processes, Ozonation, Reverse osmosis, Separation techniques, Wastewater treatment, Wastewater utilization.

The development of lavatory facilities on passenger aircraft has always been connected to the problem of reduction in weight. To limit the volume of flushing water, lavatories were equipped with recirculation toilets. Further development of toilet systems led to the installation of a central collecting system. In order to reduce the take-off weight on passenger aircraft the possible incorporation of water recycling systems from deep space flights was investigated. The treatment system, composed of several non-phase change units, was studied in laboratory scale. Mainly membrane separation techniques (micro/ultrafiltration, reverse osmosis, electrodialysis) and ozone oxidation were examined. The pretreatment stage with screen, gap filter and micro/ultrafiltration unit is an integral part of the recycling system in order to protect the succeeding stages against clogging and biofouling. For the main treatment stage the combination of reverse osmosis and electrodialysis achieved the best quality water. With investigations conducted so far it was not possible to meet the treatment goal of drinking water quality. Residual total organic carbon identification should be carried on and the possible introduction of compounds through disinfectants in the wastewater system on the ground before departure should be avoided. (Mertz-PTT)
W91-05550

REUSE OF TREATED WASTEWATER IN AN ARTIFICIAL STREAM ('SESERAGI') IN KAWASAKI CITY, JAPAN.
Kawasaki City Sewage Bureau (Japan). Dept. of Planning.
S. Kuribayashi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2209-2214, 1991. 6 fig, 8 ref.

Descriptors: *Artificial watercourses, *Japan, *Reclaimed water, *Wastewater utilization, *Water reuse, Activated sludge, Artificial streams, Chlorination, Ozonation, Phosphorus removal, Public health, Wastewater treatment, Water quality.

Kawasaki City, Japan, intends to reuse treated wastewater from a sewage treatment plant as the water source for an artificial stream (called a seseragi) in the Kawasaki Aqua-promenade which is to be constructed on the riverbed of the dried-up River Egawa. Four types of treated wastewater were studied. Short streams built in the Kase Sewage Treatment Center were used for the experiments. Stream water quality requirements include factors affecting appearance, public health, and existence of aquatic life. In other words, growth of attached algae should be inhibited, pathogenic organisms should be at an acceptable level (as indicated by number of coliform bacteria), and the stream should be a suitable habitat for fish. Four types of treated wastewater were investigated: effluents from a conventional activated sludge process; a biological phosphate removal process; a biological phosphate removal process with post chlorination (addition of sodium hypochlorite); and a biological phosphate removal process with post ozonation. It was concluded that treated wastewater from the biological phosphate removal process with post ozonation was the most suitable as the water source of the artificial stream, when the three requirements were considered in conjunction with the influence of the disinfection method on the aquatic environment. (Author's abstract)
W91-05551

ANALYSIS OF SULFATE IN SEWAGE SLUDGE USING ION CHROMATOGRAPHIC TECHNIQUES.
Technical Univ. of Denmark, Lyngby. Inst. for Bioteknologi.
S. P. Petersen, and B. K. Ahring.
Journal of Microbiological Methods JMIMDQ, Vol. 12, No. 3/4, p 225-230, 1990. 2 fig, 4 ref. Danish Technical Science Research Council Grant 5.17.4.6.17.

Descriptors: *Analytical techniques, *Chemical analysis, *Ion exchange chromatography, *Pollutant identification, *Sludge, *Sulfates, *Wastewater analysis, Anaerobic digestion, Biodegradation, Laboratory methods, Raw wastewater.

A high-pressure liquid ion chromatography method for analyzing sulfate in sewage sludge was applied for the determination of sulfate reduction rates in anaerobic digester systems. The eluent used was a borate/gluconate solution. Prior to analysis, a clean-up procedure was used in order to avoid interference from organic compounds. Two sample preparation columns were used for clean-up, a SEP-PAK C-18 column and a SEP-PAK Accel CM column. Conductivity detection was applied, which allowed a detection limit of 635 pmol. In spite of a 10 times dilution during the clean-up procedure, sulfate concentrations down to 50 microM could be quantified. The method showed a good recovery (>91%), when sulfate standards were measured in raw and anaerobic digested sludge. The method was used to quantify sulfate reduction rates in anaerobic digester systems. The values for reduction rates obtained were in good agreement with earlier findings using radiotracer techniques. The results demonstrate the feasibility of ion chromatography techniques for determination of sulfate concentrations or sulfate reduction rates even for systems with high concentrations of analytically of interfering compounds. (Agostine-PTT)
W91-05571

USING BREAKTHROUGH CURVES FOR PARAMETER ESTIMATION IN THE CONVECTION-DISPERSION MODEL OF SOLUTE TRANSPORT.
Hiroshima Univ. (Japan). Dept. of Environmental Science.
For primary bibliographic entry see Field 2G.
W91-05600

STUDY AND RECOMMENDATIONS ON THE SAN GERMAN VAULTED BRICK STORM SEWER SYSTEM.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
L. Pumarada-O'Neill, and M. Cruz-Arocho.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, MD. (1990). p 227-236, 2 fig, 9 ref. Dept. of the Interior Water Research and Development Grant No. 14-08-0001-G-1249 (Proj. no. 5).

Descriptors: *Hydraulic structures, *Puerto Rico, *San German, *Sewer systems, *Storm sewers, *Storm water, *Tropical hydrology, Flood control, Pipes, Sewers, Tourism, Upgrading, Wastewater.

The storm water drainage of a 126 acre basin within the city of San German, Puerto Rico, is through a system of vaulted brick tunnels covering former surface streams. This tunnel system, covering Quebrada Manzanares and its tributaries, has resulted from the expansion of an urban area in a wet, hilly environment. The streambeds were vaulted over haphazardly, segment by segment, between 1820 and 1917. The segments correspond to arch bridges and culverts and to barrel vaults erected by landowners in order to build structures on properties crossed by the stream. The system's definite tourism potential is affected by several factors, principally flash floods during storm events and polluted water due to illegal discharges of raw sewage. Recommendations are to: open a service access, repair the damaged floors, stabilize the vaults, and remove the raw sewage discharges. (See also W91-05611) (Author's abstract)
W91-05634

MANAGEMENT OF SLUDGE FROM PUERTO RICO'S REGIONAL INDUSTRIAL WASTEWATER TREATMENT PLANT: PHASE 2--DEWATERING.
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
G. Pena, J. Benitez, A. Rodriguez, and R. Munoz.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 525-533, 2 fig, 4 tab, 18 ref.

Descriptors: *Industrial wastewater, *Puerto Rico, *Sludge drying, *Sludge treatment, *Tropical hydrology, *Waste management, *Wastewater treatment, Dewatering, Filtration, Mathematical studies, Model studies, Vacuum filtration, Wastewater facilities.

The most important variables influencing the performance of vacuum filters were studied for the particular case of dewatering the primary and digested sludges from the Barceloneta Regional Wastewater Treatment Plant. Jar tests were performed to determine the optimum coagulant requirements for both types of sludge. Buchner funnel tests were used to measure their specific resistances at an applied vacuum of fifteen inches of mercury. The specific resistance for the digested sludge was found to be significantly higher than for the primary sludge. A model was developed, based on Darcy's law, to correlate the loading to a vacuum filter with operational parameters, such as applied pressure, solids deposited per unit volume of filtrate, and form time. Experimental data were obtained through filter leaf tests to evaluate the empirical parameters of the model. The experimental results were correlated using a non-linear regression program. A statistical analysis of the regression results led to the conclusion that the model developed was a satisfactory representation of a behavior of a vacuum filter and, therefore, could be used for the design of a full-scale facility for the dewatering of the sludges from the Barceloneta plant. (See also W91-05611) (Author's abstract)
W91-05664

REMOVAL OF GIARDIA SPP. BY CONVENTIONAL WATER AND SEWAGE TREATMENT PROCESSES AND PRESENCE OF CYSTS IN SURFACE WATERS OF PUERTO RICO.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
I. E. Correa, G. M. Yumet, and G. A. Toranzos.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, PR., July 22-27, 1990. American Water Resources Assoc. Bethesda, MD. (1990). p 535-541, 3 tab, 16 ref. NIH Grants RR-2657 and RR-8102, Sea Grant 5-35338, and Water Resources Research Inst. Grant 14-080001-G1611.

Descriptors: *Giardia, *Human pathogens, *Puerto Rico, *Surface water, *Tropical hydrology, *Wastewater treatment, *Water treatment, Epidemiology, Filtration, Microbiological studies, Protozoa, Public health, Water quality.

Sewage treatment plants, surface, marine and drinking waters in Puerto Rico, were sampled for the incidence and prevalence of Giardia spp. Cysts were concentrated from large volumes (40-800 L) of water of sewage onto polypropylene cartridge filters and detected by indirect immunofluorescence. The sewage treatment plants sampled were shown to remove from 4.3% to 100% of the cysts present in the influent. The presence of Giardia spp. (2.0-195 cysts/100 mL) was demonstrated in rivers, lakes and marine waters. No Cryptosporidium oocysts were detected in any of the samples. To date, very few cryptosporidiosis cases have been observed in Puerto Rico. The absence of Cryptosporidium oocysts in domestic sewage, together with the few cases reported, indicate that this parasite is rarely present on the island. However, the large numbers of Giardia cysts in sewage and the presence on this parasite in the environmental waters indicate its prevalence in the population. (See also W91-05611) (Author's abstract)
W91-05665

METAL-BEARING WASTE STREAMS: MINIMIZING, RECYCLING AND TREATMENT.
Jacobs Engineering Group, Inc., Pasadena, CA.
M. Meltzer, M. Callahan, and T. Jensen.
Noyes Publications, Park Ridge, New Jersey. 1990. 406p. Pollution Technology Review No. 196.

Descriptors: *Hazardous wastes, *Heavy metals, *Industrial wastes, *Metal-finishing wastes, *Recycling, *Waste reduction, *Waste treatment, *Wastewater treatment, Metals, Operating policies, Waste recovery, Wastewater management, Water quality management.

Alternatives to land disposal of hazardous metal waste streams were analyzed, with special attention to methods that prevent waste generation. Source reduction, recycling, and treatment strategies were examined. Industrial operations that are responsible for generating significant amounts of metal wastes were examined: metal casting, surface cleaning and stripping, surface treatment and plating, draining and rinsing, and coating. Also examined were refinery processes, printed circuit board manufacturing, and photofinishing. Metal bearing waste streams from these activities include spent process solutions, contaminated rinse waters, and emission waste collected by air pollution control equipment. The waste minimization strategies identified are both technical and organizational. Technical options include changes in raw materials and manufacturing processes, and frequently involve equipment modifications. Organizational changes involve scheduling and purchasing modifications, training programs, and better process documentation procedures. Part I of the book details various industrial operations and waste streams and suggested methods of treatment. Part II contains 25 papers from 'Metal Waste Management Alternatives--Minimizing, Recycling, and Treating Hazardous Metal Wastes, Symposium Proceedings', sponsored by California Department of Health Services in cooperation with the U.S. EPA. (See W90-05669 thru W90-05693) (MacKeen-PTT)
W91-05668

IMPLEMENTATION OF A HEAVY METALS REDUCTION PROGRAM IN THE CITY OF LOS ANGELES.
Los Angeles City Bureau of Sanitation, CA.
For primary bibliographic entry see Field 5G.
W91-05673

SOURCE REDUCTION OPPORTUNITIES IN THE PLATING INDUSTRY.
Minnesota Technical Assistance Program, Minneapolis.
T. Foecke.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. 207-217. 22 ref.

Descriptors: *Industrial plants, *Industrial wastes, *Industrial wastewater, *Metal-finishing wastes, *Waste reduction, *Wastewater management, Chromium, Cyanide, Electroplating, Hazardous wastes, Process control, Process modification.

Material substitution options for waste reduction include the use of deionized water in place of tap or softened water, the use of zinc chloride or alkaline zinc in place of zinc cyanide in plating solutions, and trivalent chromium in place of hexavalent ions in process solutions. Process modifications for waste reduction include use of drainboards to catch drips, agitation to improve rinsing efficiencies, utilization of flow restrictors and use of conductivity cells on flow controllers. Spray rinses and air knives can reduce the amount of solution carried over subsequent process steps. Process modifications which require floor space in addition to capital and downtime are dragout recovery and multiple rinse tanks. Modified operating practices include process solution control, training and education, withdrawal time, extended drain times, contact times, parts orientation, and housekeeping practices. Implementing source reduction in a plating operation can be described as a series of loops, with sequential use of process modification, material substitution and operating practice modification strategies. (See also W91-05668) (MacKeen-PTT)
W91-05674

CASE STUDY OF A MINIMUM DISCHARGE, HEAVY METAL WASTE REDUCTION SYSTEM AT AEROSCIENTIFIC CORPORATION, ANAHEIM, CALIFORNIA.
Toxic Recovery Systems International, Elk Grove, CA.
G. Hulbert, and B. Fleet.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 245-250. 2 fig.

Descriptors: *Heavy metals, *Industrial wastes, *Metal-finishing wastes, *Waste recovery, *Waste reduction, *Wastewater management, *Wastewater treatment, *Water pollution control, California, Copper, Ion exchange, Lead, On-site wastewater treatment, Tin.

Increasing public concern about the effects of various chemical pollutants has caused governments to enforce stringent environmental legislation which is now causing these industries to seriously re-evaluate their waste-management strategies and options along with the liabilities and future costs associated with their present practices. As a result of these pressures, many industries, especially those generating heavy-metal waste streams--including printed-circuit board fabricators, semiconductor manufacturers, and metal finishers--are seeking alternative waste-management strategies. A waste-treatment system to reduce heavy metals in wastewater at Aeroscientific Corporation, Anaheim, California, allows the recovery of chelated copper, unchelated copper, tin, and lead from process dumps and rinses. Metals are retrieved as sheets and up to 90% of the plant's process water is recycled to the manufacturing process as high-purity deionized water. The system comprises ion exchange, electrolytic recovery, unchelated copper, chelated copper, tin/lead, demineralization, discharge control and process control components. Installation was completed in 4 months and the system is undergoing an economic and performance evaluation by the California Department of Health Services. (See also W91-05668) (MacKeen-PTT)
W91-05678

RECOVERY OF RINSE WATER AND PLATING BATH FROM PROCESS RINSES USING ADVANCED REVERSE OSMOSIS.
Water Technologies, Inc., Eden Prairie, MN.
R. R. Rich, and T. von Kuster.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 252-259. 4 fig.

Descriptors: *Industrial wastewater, *Metal-finishing wastes, *On-site wastewater treatment, *Reverse osmosis, *Waste recovery, *Wastewater treatment, *Water pollution control, Control systems, Electroplating, Metals, Wash water, Waste management.

The use of advanced reverse osmosis (ARO) for recovery of rinse water and plating bath can achieve 1,000-10,000 fold concentration of solutes using lower performance membranes. The system is a closed loop, remotely controlled and operated. Testing of the ARO system has been completed on over 50 plating and metal finishing solutions at a wide range of pH. The main constraints on ARO are highly concentrated, oxidative solutions such as nitric acid, chromic acid and peroxysulfuric etchant. Rinse purification and metal recovery from these solutions shortens membrane life, which is typically 4-6 months in other applications. ARO systems are operating in several categories of metal finishing: electronic parts and circuit board manufacture, functional (cyanide) plating, and aluminum coating and finishing. It is concluded that on-site recovery using ARO allows regulatory goals to be met at a lower cost than that of hazardous waste disposal. (See also W91-05668) (MacKeen-PTT)
W91-05679

SOLIDS DETOXIFICATION: METALS RECOVERY.
Enviroscience, Inc., Hot Springs, AR.
C. T. Philipp.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 260-269. 6 fig.

Descriptors: *Heavy metals, *Metal-finishing wastes, *Slags, *Sludge treatment, *Waste recovery, *Waste treatment, Chromium, Electroplating, Hazardous wastes, Industrial wastes, Recycling, Solid wastes, Waste management.

Metal oxides can be strongly bonded to silica and solidified in a slag formulation. Many slags are notably resistant to solution or leaching in groundwaters. A system of slag formulations which provide complete fusion of sludges below 1250 C was devised. Hexavalent chromium could be dissolved in these slags to amounts of about 6% and remain resistant to leaching. At the fusion temperatures of these slags, much of the metal contents could be recovered by reduction with carbon. The slagging system comprises the following: sludge dryer, blender, melting furnace, hood and duct over the melting unit, and scrubber. Recovery economics depend upon the characteristics of the filter cake, sludge generation rates, and present disposal costs. It is concluded that the slagging technology allows economically feasible recovery of metals and metal alloys from hazardous metal sludges. (See also W91-05668) (MacKeen-PTT)
W91-05680

WASTE MINIMIZATION OF HAZARDOUS WASTE SOLUTIONS IN THE ELECTROPLATING AND PRECIOUS METALS INDUSTRY USING THE FINAL TREATMENT DISTILLATION UNIT.
Drew Resource Corp., Berkeley, CA.
P. Wavrock.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 270-275. 1 fig.

Descriptors: *Hazardous wastes, *Industrial wastewater, *Metal-finishing wastes, *On-site wastewater treatment, *Waste reduction, *Wastewater treatment, *Water pollution control, Cost analysis, Distillation, Electroplating, Metals, Wash water, Wastewater management.

The 'Final Treatment' distillation unit uses a new distillation method for the treatment of wastewater from the metal-finishing industry. Two options for use of the system are available: (1) the wastewater solutions may be concentrated to a sludge to minimize the volume; or (2) drag-out solution or static wash may be reduced to about 25% of the initial volume, chemically adjusted, and returned to the plating tank. The distillation unit includes three features designed to reduce energy requirements to

0.2 KW/L of solution treated: (1) operation in a residual vacuum allows distillation to be carried out at 30-35 C; (2) a heat pump provides heat for evaporation and refrigeration for condensation; and (3) the surface on which the heat exchange takes place is constantly cleaned by a rotating blade. A plating shop generating an average of 40 gallons of nickel drag-out solutions per day has purchased a Final Treatment 50 unit for $14,800. At a cost savings of $167.28/day over having a licensed waste hauler pick up 3600 gal every 90 days at $5.00/gal for removal to a state-approved disposal site, the unit will pay for itself in less than three months. As another example, a circuit-board manufacturer which produces 125 gallons/day of waste cyanide solutions is contemplating purchasing a Final Treatment 150 unit and an Aqua Clear 30 unit (to further treat the distillate) for a total cost of $64,800. At a savings of $495.79/day over paying a licensed transportation and disposal company $4.75 a gallon to remove 11,250 gallons of cyanide waste every 90 days, the payback period could be less than 4.4 months. Thus, the distillation system provides an economically feasible method for electroplating-waste minimization. (See also W91-05668) (MacKeen-PTT)
W91-05681

RECOVERY OF METALS IN CIRCUIT BOARD AND METAL PLATING MANUFACTURING.
General Dynamics Corp., Pomona, CA. Pomona Div.
A. Crane.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 276-278.

Descriptors: *Industrial wastewater, *Metal-finishing wastes, *On-site wastewater treatment, *Waste recovery, *Wastewater management, *Wastewater treatment, *Water pollution control, Cadmium, Chromium, Copper, Electroplating, Metals, Nickel, Sludge, Wash water.

General Dynamics Pomona Division installed an electrolytic system which reduced 6,000 tons/y of liquid hazardous waste to filter cake sludge. Addition of a sludge dryer allowed further reduction in the volume of sludge. Three process chemistry substitutions eliminated a major source of chrome-containing wastes. A program to reduce rinsewater flows concentrated on the elimination of duplicate processes and the installation of on-demand rinsing systems. New technologies were applied to recover saleable products from concentrated wastes. A crystallizer system was installed to recover copper sulfate. An automated printed circuit board plating process incorporating both rinse reduction and metal recovery technologies achieved a reduction of over 10 tons in weekly sludge production. Separate systems installed in the wet process metal plating production area utilize cation exchange resins to recover chrome, cadmium, copper and nickel. (See also W91-05668) (MacKeen-PTT)
W91-05682

AQUATECH SYSTEMS: A TECHNOLOGY FOR METAL WASTE RECOVERY.
Allied-Signal, Inc., Warren, NJ. Aquatech Systems.
C. H. Byszewski, and K. N. Mani.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 279-288. 8 fig, 2 tab, 5 ref.

Descriptors: *Electrodialysis, *Industrial wastewater, *Metal-finishing wastes, *Separation techniques, *Waste recovery, *Wastewater treatment, Acids, Heavy metals, Membrane processes, On-site wastewater treatment, Wastewater management, Water quality management.

Aquatech Systems is a bipolar membrane separation technology for recycling acid from waste streams. It is applicable to organic aqueous salt solutions, as well as mineral salts with either acidic, basic, or saline properties. The method is a type of electrodialysis, requiring a cell stack which is composed of hundreds of ion exchange membrane sheets and a pair of electrodes powered by DC current. An ability to split water into acid and base is what distinguishes Aquatech from conventional electrodialysis. In general, the Aquatech approach to recycling acid effluent from metal processing operations involves precipitation of the heavy metal, filtration, and regeneration of acid and base from the salt filtrate. The method has been applied to the recycling of steel pickling acid, titanium milling solution, and waste acid. The payback period for the use of the system for stainless steel waste acid recycling was calculated to be 3.6 years. Thus, the Aquatech System, used in conjunction with conventional techniques such as filtration and electrodialysis, can be used economically for the recycling of waste acid streams. (See also W91-05668) (MacKeen-PTT)
W91-05683

HEAVY METAL WASTE CONVERSION BY THERMALLY-DRIVEN CHEMICAL BONDING.
Ceramic Bonding, Inc., Mountain View, CA.
For primary bibliographic entry see Field 5E.
W91-05684

ELECTROLYTIC RECOVERY OF MERCURY METAL FROM A MERCURIC CHLORIDE-CONTAINING WASTE.
Fred Hutchinson Cancer Research Center, Seattle, WA.
D. Bender, and F. Riordan.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 298-303. 7 ref.

Descriptors: *Electrolysis, *Industrial wastewater, *Medical wastes, *Mercury, *Metal-finishing wastes, *Waste recovery, *Wastewater treatment, Anodes, Electrochemistry, Heavy metals, On-site wastewater treatment, Recycling, Wastewater management.

Heavy metal wastes from pathology cell fixation processes containing mercuric chloride with concentrations greater than 11 g/L can no longer be landfilled. In an electrolytic method for the recovery of mercury metal from mercuric chloride-containing cell fixative, the spent bath was precipitated with sodium hydroxide after electrolysis, filtered, and treated with an ion exchange resin. A standard solution of fixative containing a mercuric chloride concentration of 60 g/L was plated for 8 h and yielded 60% recovered metal. High carbon steel as the anode produced a larger amount of mercury than did steel or galvanized steel. Hydrochloric acid and calcium chloride were added to the electroplating bath to produce electrolytic activity. Other parameters affecting the efficiency of the process were voltage used, agitation of the bath, and cathode surface area. Application of this method may provide an alternative disposal option for heavy metal wastes generated in the medical research industry. (See also W91-05668) (MacKeen-PTT)
W91-05685

HYDROMETALLURGICAL RECYCLING OF METAL SLUDGE.
Recontek, Inc., San Diego, CA.
For primary bibliographic entry see Field 5E.
W91-05686

RECYCLING AND TREATMENT OF METAL-BEARING SPENT ACIDS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5E.
W91-05687

DEMETALLATION AND RECOVERY OF FUEL OIL FROM HAZARDOUS WASTE OIL.
Auburn Univ., AL. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W91-05688

MEMBRANE SEPARATION PROCESSES FOR TREATMENT OF HAZARDOUS WASTE.
Cartwright Consulting Co., Minneapolis, MN.
P. S. Cartwright.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 329-343. 13 fig, 3 tab.

Descriptors: *Hazardous wastes, *Industrial wastewater, *Membrane processes, *Metal-finishing wastes, *Reviews, *Separation techniques, *Wastewater treatment, On-site wastewater treatment, Recycling, Reverse osmosis, Ultrafiltration, Waste recovery, Wastewater management.

Membrane separation processes for hazardous waste treatment are reviewed. Industrial contaminants may exist in several forms: suspended solids, dissolved ionic species, or dissolved organic materials. Membrane processes such as cross-flow microfiltration, ultrafiltration, and reverse osmosis offer the potential for continuous removal of contaminants. Other advantages of membrane separation processes include low energy requirements, modular construction, simple maintenance, positive barrier to contaminants and ambient temperature operation. Membrane configurations with differing packing density and tolerance to suspended solids are available (tubular, hollow fiber, spiral wound, and plate and frame). Industrial applications of the processes have been made in several areas: metal finishing treatment; oily waste treatment; printed circuit effluent treatment; and semi-conductor manufacturing effluent treatment. Membrane separation processes are especially effective for recovering specific components at the point of source, allowing recycling of hazardous materials. (See also W91-05668) (MacKeen-PTT)
W91-05689

ARSENIC WASTE REDUCTION IN THE ELECTRONICS INDUSTRY.
EBASCO Environmental Services, Santa Ana, CA.
D. W. Hertz, and R. M. Holland.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 344-361. 9 fig, 2 tab, 7 ref.

Descriptors: *Arsenic, *Filtration, *Industrial wastewater, *Metal-finishing wastes, *Waste recovery, *Waste reduction, *Wastewater treatment, Cost analysis, Hazardous wastes, On-site wastewater treatment, Recycling, Wastewater management.

Methods for the reduction of arsenic wastes produced in the manufacture of gallium arsenide (GaAs) microelectronics chips were evaluated. Analysis of the waste streams at Hewlet Packard's San Jose, CA, facility indicated that arsenic solids (GaAs) represented at least 94% of the arsenic contamination found in the sludge cake produced from the hydrofluoric treatment process. Filtration was identified as the simplest potential treatment process for removal of the solids. Pilot scale operations were conducted with filtration equipment from several vendors to assess the following: removal efficiency of GaAs, overall equipment performance; corrosion resistance; final product technical specifications, purchase, operating and maintenance costs; and health, safety and environmental concerns. Results indicated that arsenic waste generation at the facility could be reduced by almost 30,000 kg per year by filtration. Potential annual cost savings include $100,000 from the sale of decontaminated HF treatment solids; $5,000 from direct GaAs recycling; $35,000 in disposal costs; and $15,000 reduced maintenance and health and safety costs. The technology may also be useful in other industries where heavy metal solids are produced. (See also W91-05668) (MacKeen-PTT)
W91-05690

BIOLOGICAL TREATMENT OF MERCURY WASTE.
Utah State Univ., Logan. Dept. of Nutrition and Food Science.
C. L. Hansen, and G. S. Choudhury.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park

Ridge, New Jersey. 1990. p 373-382. 4 fig, 26 ref.

Descriptors: *Biodegradation, *Biological treatment, *Mercury, *Metal-finishing wastes, *Sludge treatment, *Waste treatment, *Wastewater treatment, *Water pollution treatment, Bioreactors, Culturing techniques, Hazardous wastes, Heavy metals, Industrial wastes.

A biological process for the detoxification of mercury in polluted water and sludges has been developed which involves reduction of mercuric ions to mercury metal and subsequent volatilization of this hazardous metal from contaminated water and sediments. Preliminary experiments using cultures of Escherichia coli strain KP245 harboring the cloned plasmid pRR130 indicated that mercury (5 mg/L mercuric chloride) increases the lag phase but does not affect the growth rate. It was also demonstrated that the growth rate was minimal during rapid mercury removal, after which growth resumed. A continuous biological process was developed for mercury removal, involving addition of mercury contaminated waste to a continuous mixed culture of resistant organisms maintained on raw sewage. The bioreactor was able to remove mercuric ions from sewage containing 70 mg/L mercury at the rate of 2.5 mg/L h with an efficiency of 88%. Two types of adsorbent for recovery of elemental mercury are under investigation. A full-scale bioprocess for mercury removal has been designed to use whey permeate as the energy source. (See also W91-05668) (MacKeen-PTT)
W91-05692

COPPER MINE DRAINAGE TREATMENT PLANT DRIVEN BY WATER WHEEL.
California Univ., Richmond. Richmond Field Station.
For primary bibliographic entry see Field 5G.
W91-05693

EFFECTS OF HEAT TREATMENT ON THE HIGH-RATE ANAEROBIC DIGESTION OF HUMAN WASTES CONCENTRATES.
Nishihara Environmental Sanitation Research Corp. Ltd., Tokyo (Japan).
M. Takashima, Y. Sugawara, T. Ohkawa, and Y. Ohkubo.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1137-1145, 1991. 9 fig, 2 tab, 8 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Domestic wastes, *Heat treatment, *Methanogenesis, *Organic wastes, *Wastewater treatment, Calcium, Digestion, Experimental data, Fatty acids, Inhibition, Inhibitors, Particulate matter, Powdered activated carbon, Retention time.

The solubilization of particulate organic matter is generally rate-limiting in the anaerobic digestion of human wastes. It appears that the use of a physical treatment, such as heat treatment, is necessary for high-rate solubilization of the rather refractory particulate substrates. The effect of heat treatment on the solubilization of particulate organic matter and methane production in concentrated human wastes was examined by conducting a series of batch and continuous (i.e., 35 day duration) experiments at temperatures which ranged between 100 C and 250 C. In batch studies, the heat treatments above 150 C were found to inhibit methane production to a severe degree as the temperature was raised. The addition of powdered activated carbon (PAC) or calcium to heat-treated concentrates showed a complete reduction of the inhibition. This remedial effect of calcium and measurements on volatile fatty acids indicated that long-chain fatty acids were the inhibitory substances produced. The effectiveness of heat treatment at 150 C and 175 C was demonstrated in a continuous study which simulated a high-rate digestion process having a solids separation device. The continuous experiment was conducted at a hydraulic retention time (HRT) of 2.5 days and a solids retention time (SRT) of about 15 days with a mesophilic operating temperature of 35 C. The fraction of particulate substrates solubilized increased about two-fold, and methane production increased 40% when combined with the PAC addition. (Author's abstract)
W91-05720

DEVELOPMENT OF HIGH-PERFORMANCE THERMOPHILIC TWO-PHASE DIGESTION PROCESS.
NGK Insulators Ltd., Handa (Japan). Research and Development Lab.
N. Aoki, and M. Kawase.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1147-1156, 1991. 5 fig, 4 tab, 8 ref.

Descriptors: *Anaerobic digestion, *Methanogenesis, *Sludge conditioning, *Sludge digestion, *Sludge treatment, *Wastewater treatment, Enzymes, Experimental data, Experimental design, Fatty acids, Fermentation, Japan, Methane bacteria, Suspended solids.

Anaerobic digestion of anaerobic sewage sludge leads to the generation of methane gas and reduction of the sludge volume. Because conventional digestion requires a long time, the digestion facilities must be large. The destruction of volatile suspended solids (VSS) appears to be the rate-determining step in the sludge digestion process and so may partially contribute to the aforementioned problem. The digestion of excess sewage sludge was studied using a bench scale experimental design known as the High-Performance Thermophilic Two-Phase Digestion (HPTTD) process. This thermophilic process consists of sludge conditioning, acidification, and methanation steps. In the conditioning step, sewage sludge is conditioned with thermal treatment at 90 C for 1 hr. The sludge is then dosed with a proteolytic enzyme. In the next step, acidification, acid fermentation is carried out at 70 C. This is believed to promote the destruction of VSS and the accumulation of volatile fatty acids. In the methanation step, an anaerobic fixed-bed reactor is used to immobilize methanogenic microbes. The microbes are then kept at high concentrations in the reactor so that methane fermentation can be carried out rapidly. The results indicated that the reduction ratio of VSS at 20 days of hydraulic retention time (HRT) was increased to 78% which was well above those in conventional digestion processes. Also, at around 5 days HRT, the HPTTD process demonstrated a high reduction of VSS as compared with the conventional digestion process. (Korn-PTT)
W91-05721

COMPARISON OF ONE-PHASE AND TWO-PHASE ANAEROBIC DIGESTION PROCESSES IN CHARACTERISTICS OF SUBSTRATE DEGRADATION AND BACTERIAL POPULATION LEVELS.
Tsinghua Univ., Beijing (China). Dept. of Environmental Engineering.
T. C. Zhang, and T. Noike.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1157-1166, 1991. 6 fig, 7 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Methanogenesis, *Wastewater treatment, Bacterial analysis, Chemical oxygen demand, Degradation, Hydrogen ion concentration, Retention time, Substrates, Wastewater reactors.

A comparison was made between one-phase and two-phase anaerobic digestion processes in order to clarify the differences in the characteristics of substrate degradation and bacterial population levels. The investigation was performed using chemostat-type reactors to which starch was fed as substrate. Both one-phase and two-phase processes were operated under the same experimental conditions. By decreasing the solids retention time (SRT) of both systems from 10.2 days (d) to 5 d, 2.5 d, and 1.75 d, it was found that the two-phase system was more stable with change in pH than the one-phase system. The methane recovery rates increased from 4% to 9% and the chemical oxygen demand (COD) removal rates increased from 3% to 10% in the two-phase system. However, the methane recovery rate and the COD removal rate in the one-phase system were slightly higher than those in the two-phase system at a SRT of 10.2 d. The concentration of propionate in the effluent of the one-phase system was 30% to 50% higher than that in the two-phase system. The concentrations of acetate and butyrate in the one-phase system were slightly lower than those in the two-phase system. The enumeration of the bacteria was performed by the most probable number (MPN) method. While the population levels of acidogenic bacteria in both systems were in the same order (10 to the 8th power to 10 to the 10th power MPN/ml), the two-phase system could exploit the acidogenic potentiality to its maximum limit. The number of HAc-utilizing methanogens in the methanogenesis of the two-phase system were 2 to 10 times higher than in the one-phase system. Therefore, the one-phase system cannot be regarded simply as the sum of acidogenesis and methanogenesis. (Author's abstract)
W91-05722

PILOT AND FULL-SCALE EXPERIENCE IN ANAEROBIC TREATMENT OF BREWER'S YEAST PROCESSING WASTEWATER.
Kurita Water Industries Ltd., Atsugi (Japan).
M. Yoda, S. Imabayashi, and N. Suzuki.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1167-1177, 1991. 9 fig, 6 tab, 5 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Food-processing wastes, *Sludge, *Wastewater treatment, Chemical oxygen demand, Sludge bed, Sludge digestion, Sludge treatment, Trace metals, Wastewater reactors, Yeasts.

Anaerobic processes are extremely attractive for the treatment of easily degradable medium-strength to high-strength wastewaters. Among several anaerobic processes, the upflow anaerobic sludge blanket (UASB) process is generally considered as one of the most efficient processes. However, the efficiency of the process depends on the existence of granular sludge. While it usually requires a great deal of time to cultivate sufficient granular sludge, the anaerobic expanded microcarrier bed (MCB) process may provide a potential source of the necessary sludge. The MCB process, which utilizes fine particles (i.e., particle diameters of 75-100 micrometers) as expanded bed media, was applied to the wastewater from a brewer's yeast processing plant. Based on the results of the pilot study, in which 97 to 99% chemical oxygen demand (COD) removals were maintained at 13 to 24 kg COD/cu m/day, a full-scale MCB plant with a total reactor volume of 985 cu m was constructed. Though not found in the pilot study, cobalt and nickel were found to be deficient in the wastewater and had to be supplemented during start-up. However, a sufficient amount of granular sludge was cultivated so that the reactor could accept the design loading within three months of operation and achieve average COD removal of 93.5% at 9.8 kg COD/cu m/day. Thus, it was clearly demonstrated in the full-scale installation that the MCB process could provide a reliable and predictable way to cultivate the granular sludge necessary for efficient anaerobic treatment. (Author's abstract)
W91-05723

PILOT-SCALE DEMONSTRATION OF TWO-PHASE ANAEROBIC DIGESTION OF ACTIVATED SLUDGE.
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
S. Ghosh.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1179-1188, 1991. 3 tab, 29 ref.

Descriptors: *Activated sludge, *Activated sludge process, *Anaerobic digestion, *Foaming, *Methanogenesis, *Wastewater treatment, Fermentation, Hydrolysis, Nitrates, Organic acids, Pilot plants, Sulfates, Temperature effects, Volatile solids.

Pilot-scale anaerobic digestion process was developed to stabilize concentrated (7-5%) activated sludge at a 12-day solid retention time (SRT) and a loading rate of 5 kg volatile solids (VS)/cu m/d. The pilot system exhibited an unusually high VS reduction of 73%, an aggregated carbohydrate-protein-lipid reduction of 71%, and a methane yield of 0.3 cu m/kg VS added. Optimum acido-

genic fermentation producing 9500 mg/l of organic acids was achieved at a hydraulic retention time (HRT) of 3 days and a loading rate of 16 kg VS/cu m/d or higher. Enhanced acidogenic hydrolysis and prehydrolysis of polymers and nocardial residues eliminated digester foaming. Sulfate and nitrate reductions, and syntrophic methane fermentation occurred during acidogenic conversions. Acetogenesis and aceticlastic methane fermentation were predominant in the methane digester, which generated 93% of the system methane production. Contrary to literature reports, there was no inhibition of acetogens or methanogens at a high ammonia-N concentration of 2500 mg/l and pH 7.7. The acid and methane digesters could be started quickly. They were resilient to temperature drops and loading fluctuations. Acid fermentation of 8% of the plant's waste activated sludge (WAS) and addition of the resulting fermentation products (enzymes, organic acids, etc.) to the full-scale high-rate digester increased VS reduction by 46% and eliminated severe foaming. (Author's abstract)
W91-05724

PREVENTION OF LIPID INHIBITION IN ANAEROBIC PROCESSES BY INTRODUCING A TWO-PHASE SYSTEM.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
T. Komatsu, K. Hanaki, and T. Matsuo.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1189-1200, 1991. 9 fig, 5 tab, 10 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Fatty acids, *Inhibition, *Lipids, *Wastewater treatment, Experimental design, Laboratory methods, Methanogenesis, Saturation, Wastewater reactors.

The inhibitory effect of lipids and prevention of this inhibition in a two-phase anaerobic wastewater treatment process were examined using laboratory-scale reactors and batch experiments. Lipids were satisfactorily degraded in a two-phase anaerobic filter while in a single-phase system, inhibition resulted in poor lipid degradation. Unsaturated long-chain fatty acids (LFAs) had a greater inhibitory effect than saturated LFAs. Methane production as well as beta-oxidation (degradation of saturated LFAs) were inhibited by unsaturated LFAs. The saturation of unsaturated LFAs was not inhibited, and palmitate (C16:1) was accumulated in the degradation of oleate (C18:1) or linoleate (C18:2). Greater inhibition was observed at low pH values. Continuous operation of a suspended-growth acidogenic reactor showed that hydraulic retention times (HRTs) of no less than 8 hours were necessary to mitigate the inhibition in a two-phase process. The fact that saturation of oleate occurred at HRTs no less than 8 hours suggests that the saturation of unsaturated LFAs in an acidogenic reactor is essential in the prevention of lipid inhibition in two-phase anaerobic processes. (Author's abstract)
W91-05725

INFLUENCE OF GLUCOSE SUPPLEMENT ON THE DEGRADATION OF CATECHOL.
National Cheng Kung Univ., Tainan (Taiwan). Graduate Inst. of Civil Engineering.
P. Hwang, and S. Cheng.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1201-1209, 1991. 20 fig, 1 tab, 13 ref. National Science Council, Republic of China, Contract No. NSC-76-0410-E006-04.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Catechols, *Industrial wastewater, *Inhibition, *Sludge bed, *Wastewater treatment, Biochemical tests, Biodegradation, Glucose, Microbial degradation, Microbiological studies, Substrates, Temperature effects, Wastewater reactors.

Catechol, a major chemical constituent in coal gasification wastewater, not only exhibits resistance to conventional biological treatment processes, but is also toxic to microbes. Therefore, the toxic nature of catechol, limits its biodegradability. A series of batch Biochemical Methane Potential (BMP) tests and two parallel Upflow Anaerobic Sludge Bed (UASB) processes were conducted to investigate the influence of glucose supplement on the degradation of catechol. The substrate inhibition of catechol caused by thermal shock, restart, or other operating problems was also studied. The results from the batch tests and UASB process showed that the glucose supplement could accelerate the degradation rate of catechol, and the effect was more pronounced in the higher concentration range. The mechanisms of cosubstrate utilization and the anaerobic metabolic pathway of catechol were proposed to explain these symptoms. Data of both batch tests and UASB processes indicated that a high concentration of catechol did inhibit the bioactivity of anaerobic microbes. Effluent recirculation could maintain appropriate in-tank concentration to promote high bioactivity in the reactors. Low temperature could also result in inhibition of the microbes. The temperature factor (theta), with a value of 1.093 estimated from the batch data, indicated that anaerobic microbes were very sensitive to temperature change. Low bioactivity and increased catechol accumulation were observed during the restart period. It is suggested that a lower volumetric loading should be applied in order to resume the bioactivity and to restart the reactor. (Author's abstract)
W91-05726

ANAEROBIC BACTERIA DEGRADING LOW MOLECULAR CHLORINATED FATTY ACIDS AND RELATED COMPOUNDS.
Fermentation Research Inst., Yatabe (Japan).
K. Nakamura, Y. Kamagata, K. Tanaka, K. Matsuda, and M. Tasaki.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1211-1218, 1991. 3 fig, 2 tab, 15 ref.

Descriptors: *Anaerobic digestion, *Biodegradation, *Biological wastewater treatment, *Clostridium, *Fatty acids, *Microbial degradation, *Microbiological studies, *Substrates, *Wastewater treatment, Acetates, Bacteria, Butyrates, Japan, Microorganisms.

The anaerobic degradation of chlorinated organic compounds, in particular fatty acids, has been investigated for application to anaerobic treatment of wastewaters. In the study, 4-chlorobutyrate and acrylate were used as model substrates to examine the anaerobic degradation of chlorinated fatty acids and related compounds. In addition, anaerobic bacteria were isolated from the enrichment culture using each compound. Two anaerobic rod-shaped bacteria, strains K-1 and ACR were isolated from mesophilic digester sludge acclimatized with 4-chlorobutyrate or acrylate as the main energy and carbon source. Both bacteria have tentatively been classified in the genus Clostridium because of their cell morphology and spore formation. Strain K-1 could utilize chlorinated compounds such as 4-chlorobutyrate and 3-chlorobutyrate, and the main products were butyrate and acetate, propionate and acetate, respectively. Crotonate and 3-hydroxybutyrate could also be degraded by strain K-1 and the same products from the degradation of 4-chlorobutyrate were observed. Strain ACR could utilize acrylate to produce propionate and acetate. It could also utilize chlorinated fatty acids such as 4-chlorobutyrate and 3-chlorobutyrate. However, neither of the strains could utilize saturated fatty acids such as propionate and butyrate. Reduction dechlorination or saturation of unsaturated bonds may thus possibly serve as a regeneration system for a reduced coenzyme, which may by formed in an oxidation pathway of such compounds to acetate. (Korn-PTT)
W91-05727

ANAEROBIC TREATMENT OF THERMAL SLUDGE CONDITIONING LIQUOR AND CHARACTERISTICS OF GRANULAR SLUDGE PRODUCED.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
T. Kimata, M. Tada, K. Tanaka, K. Shinabe, and K. Shimizu.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1219-1228, 1991. 8 fig, 5 tab, 10 ref.

Descriptors: *Anaerobic digestion, *Sludge conditioning, *Sludge treatment, *Wastewater treatment, Chemical oxygen demand, Digested sludge, Methanogenesis, Microbial degradation, Sludge analysis, Wastewater reactors.

The thermal sludge conditioning process is used for sludge dewatering. However, the supernatant produced from thickeners and dewatering machines (i.e., the thermal sludge conditioning liquor) has extremely high organic strength and sometimes causes undesirable effluent quality when the supernatant is directly returned to the main stream. Thermal sludge conditioning liquor from a municipal wastewater treatment plant was successfully treated with a pilot-scale upflow anaerobic hybrid reactor with an effective volume of 10.4 cu m. More than 70% of soluble chemical oxygen demand (COD) in the influent was removed even at an organic loading as high as 30 kg COD/cu m/day. Though the reactor was seeded with an anaerobically digested sludge, granular sludge was produced in the reactor. The ratio of granular sludge to the solids in the reactor increased up to 70% at the end of the experiment. Volatile fatty acids remaining in the effluent were consistently less than 60 mg/l after the day when stable treatment had been achieved. Biological activity of the granular sludge was measured as a methane production rate using an acetate solution. The methanogenic activity of the granular sludge was 0.8 to 1.1 kg CH4 as COD/kgSS/day and much higher than for anaerobically digested sludge. Seventy percent of the sludge in the reactor was granular sludge with diameters which ranged from 0.3 to 3.0 mm. (Korn-PTT)
W91-05728

INCREASED STABILITY OF ANAEROBIC DIGESTION BY CONTROLLED RECIRCULATION.
National Central Univ., Chung-Li (Taiwan). Dept. of Civil Engineering.
C. Ouyang, and T. Chang.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1229-1237, 1991. 11 fig, 2 tab, 12 ref.

Descriptors: *Activated sludge, *Anaerobic digestion, *Digested sludge, *Sludge digestion, *Sludge treatment, *Wastewater treatment, Biological wastewater treatment, Chemical oxygen demand, Methanogenesis, Microbial degradation, Recycling, Wastewater reactors.

While anaerobic sludge digestion is considered the most important phase in a municipal wastewater treatment plant, the process still suffers from a reputation of unreliability. The characteristics of treating municipal sludge by the anaerobic activated sludge digestion (AASD) system were investigated. In order to provide optimum growth of a methane producing population directly responsive to the substrate loading, the AASD system consisted of a semi-continuously fed, completely mixed reactor followed by solid/liquid separation. The effluent and waste sludge was discharged from the separator and different amounts of settled biomass were returned back to the reactor. The results of the investigation indicated that, with a total solids (TS) content of 2%, the nonbiodegradable portion of the substrate concentration contained in the primary and secondary sludge was 40.6% and 35.1% on the basis of total volatile solids (TVS) and chemical oxygen demand (COD), respectively. A maximum specific growth rate of 0.363/day was also obtained in the study, based on COD. The reactions at a recycling ratio of R=1 and R=3 were considerably more stable than those achieved in conventional or other recycling ratio digestors with a hydraulic retention time (HRT) of 9 days or longer. The gas production and bioactivity is also higher than that normally produced by the conventional single-stage digestion system. The experimental results indicated that the dilution rate exceeds the maximum specific growth rate as the HRT is decreased from 9 days to 6 days. The significant saving in reactor volume and enhanced methane generation should offset the energy required for digested sludge recycling. (Author's abstract)
W91-05729

CALCIUM CARBONATE PRECIPITATION IN ANAEROBIC WASTE WATER TREATMENT.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
K. Svardal.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1239-1248, 1991. 4 fig, 1 tab, 10 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Calcium, *Calcium carbonate, *Chemical precipitation, *Hydrogen ion concentration, *Model studies, *Wastewater treatment, Chemical oxygen demand, Equilibrium, Solubility, Solubility coefficient, Thermodynamics, Total organic carbon.

Precipitation of calcium in anaerobic treatment can be a severe problem, especially for fixed bed reactors where the flow passage can become blocked. In order to assess calcium precipitation quantitatively, an equilibrium model has been developed. The calcium carbonate equilibrium determines the solubility of calcium for drinking and surface waters. The main end products in anaerobic degradation of organic wastes are carbon dioxide and methane. The amount of carbon dioxide formed in anaerobic treatment depends on the amount of chemical oxygen demand (COD) and total organic carbon (TOC) removed and on the pH, and is, therefore, not constant. The equilibrium model developed in the investigation enabled the prediction of chemical equilibria in anaerobic reactors on the basis of the usual pollution parameters of the wastewater. With the help of the model, the pH value that would result and the maximum solubility of calcium ions could be calculated. The solubility of calcium carbonate is mainly dependent on the value of the solubility product. With measurements for the solubility product of calcium carbonate obtained in this study, pK values between 7 and 7.4 were calculated. The investigation also determined that the danger of a precipitation of calcium carbonate in an anaerobic reactor increases with an increase of removable COD in the wastewater. With COD values below 2000 mg/l and weakly buffered waste waters, an increase in the alkalinity with the addition of CaO or Ca(OH)2 can be taken into consideration without the expectation of problems with precipitation of calcium carbonate. (Korn-PTT)
W91-05730

SEQUENCING BATCH ANAEROBIC REACTORS FOR TREATMENT OF A HIGH-STRENGTH ORGANIC WASTEWATER.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Suthaker, C. Polprasert, and R. L. Droste.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1249-1257, 1991. 6 fig, 3 tab, 4 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Wastewater reactors, *Wastewater treatment, Biogas, Kinetics, Microbial degradation, Substrates.

Laboratory-scale experiments were carried out to study the performance of sequencing batch anaerobic reactors (SBAR) with respect to substrate removal and biogas production using a synthetic high-strength organic wastewater. A major advantage of the sequencing batch reactor process is the settling of biomass under quiescent conditions due to the absence of hydraulic transients which could affect biomass sedimentation. In general, each reactor in the SBAR process has five operating periods (i.e., fill, react, settle, draw, and idle periods). Biological reactions commence during the fill period and continue to the end of the react period. The laboratory experiments on SBAR were conducted for about 6 months and the main operating parameters studied were the cycle period, the fill:react ratio, and the fill period. The fill:react ratios and the cycle periods of SBAR were varied to study their effects on SBAR performance. Maximum soluble substrate removal of 73% was observed in the SBAR operating with a cycle period of 16 days and a fill:react ratio of 1:3. The treatment performance of the SBAR was affected more by the fill period than the fill:react ratio. The maximum biogas production rate of 4.8 L/day was obtained in the SBAR operating at a cycle period and fill period of 12 and 6 days, respectively. The SBAR reactions could be modelled by quasi-second order kinetics. However, it is recommended that verification of the proposed kinetic model on soluble substrate removal in the SBAR should be done additionally with other experimental data where influent substrate concentrations, initial biomass concentrations, and the fraction of sludge reserve are varied. (Korn-PTT)
W91-05731

COMPETITION AND INHIBITION OF SULFATE REDUCERS AND METHANE PRODUCERS IN ANAEROBIC TREATMENT.
Korea Univ., Seoul (Republic of Korea). Dept. of Civil Engineering.
E. Choi, and J. M. Rim.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1259-1264, 1991. 8 fig, 1 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Methane bacteria, *Methanogenesis, *Substrates, *Sulfur bacteria, *Wastewater treatment, Anaerobic bacteria, Competition, Laboratory methods, Sulfates, Sulfides.

The competition for substrate between sulfate-reducing and methane-producing bacteria was investigated for the selection of a proper anaerobic treatment process. The inhibitory effects of the sulfide produced as a result of microbial sulfate reduction were also evaluated. Substrates used in the investigation were synthetic waste prepared with various COD/SO4(2-) ratios, and industrial wastes. The synthetic substrate was composed of acetic acid supplemented with nutrients. The laboratory anaerobic contact units used were seeded with polluted marine sediments. A municipal digester was also used. The results of the study revealed that sulfate reducers and methane producers were very competitive at COD/SO4(2-) ratios between 1.7 and 2.7. As the ratio increased, methane producers predominated, while sulfate reducers were dominant as the ratio decreased. Inhibitory concentrations of 2000 mg/l sulfate (160-200 mg/l sulfide) for sulfate reducers and 1200 mg/l sulfate (120-140 mg/l sulfide) for methane producers were obtained in those experiments conducted with synthetic substrate. However, sulfide inhibitory concentrations varied with the hydraulic or organic loading rates and particular substrate used. In general, as loading rates increased, the inhibitory effect was greater. (Korn-PTT)
W91-05732

SULFUR SOURCES FOR HYDROGEN SULFIDE PRODUCTION IN BIOFILMS FROM SEWER SYSTEMS.
Aalborg Universitetscenter (Denmark). Environmental Engineering Lab.
P. H. Nielsen.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1265-1274, 1991. 6 fig, 2 tab, 27 ref.
Danish National Science Foundation Grant No. 16-3677.H-747.

Descriptors: *Anaerobic digestion, *Biofilms, *Odors, *Sewer systems, *Sulfur compounds, *Wastewater treatment, Anaerobic bacteria, Industrial wastewater, Kinetics, Model studies, Sewers, Substrates, Sulfates, Sulfides, Sulfites, Thiosulfates.

The relative significance of different inorganic and organic sulfur compounds on the sulfide production in anaerobic biofilms grown on domestic wastewater was investigated. Biofilms originally grown on domestic wastewater with sulfate as the only electron acceptor were also able to reduce sulfite and thiosulfate. The bacteria preferred thiosulfate to sulfate if both were present and the sulfide production rates increased by a factor of 1.5. Disproportionation of thiosulfate to equal amounts of sulfide and sulfate was demonstrated to take place in the biofilms but only at low concentrations of organic substrates. Some sulfide production from the organic sulfur compounds cysteine and methionine was observed. The rates were, however, insignificant compared to sulfide production from sulfate reduction in wastewater. Biofilm activity measured as the zero order volume constant (kof) was around 0.18 mg SO4-S/cu m/h at 20 C. If the biofilms were grown on domestic wastewater enriched with sulfite or thiosulfate, kof increased about two times. The sulfide production rate from both sulfite and thiosulfate considerably higher than the rate from sulfate in these biofilms. The results were modeled using biofilm kinetics which showed that the presence of sulfite or thiosulfate in the wastewater strongly affected the potential sulfide production and could in some cases be a limiting compound in addition to organic matter. Knowledge about the presence of sulfur compounds other than sulfate in wastewater, e.g., from industrial sources, may therefore be very important to forecast sulfide buildup in sewer systems. (Author's abstract)
W91-05733

MICROBIAL CORROSION OF CONCRETE SEWER PIPES, H2S PRODUCTION FROM SEDIMENTS AND DETERMINATION OF CORROSION RATE.
Shimane Univ., Matsue (Japan). Faculty of Agriculture.
T. Mori, M. Koga, Y. Hikosaka, T. Nonaka, and F. Mishina.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1275-1282, 1991. 4 fig, 4 tab, 5 ref.

Descriptors: *Anaerobic digestion, *Corrosion, *Hydrogen sulfide, *Microbial degradation, *Pipes, *Sewer systems, *Sulfur bacteria, *Wastewater treatment, Cements, Concretes, Mortar, Sewers, Wastewater facilities.

An investigation was undertaken to evaluate the degree of microbial corrosion of concrete sewer pipes under anaerobic conditions. It has been determined that H2S, a highly corrosive compound, is produced from slime layers on pipe walls. However, only a small slime layer is found on the pipe wall under anaerobic conditions if the flow rate is relatively high. Samples of corroded sewer pipe and mortar from the Ohmuta, Japan, treatment plant were prepared, while sediment samples were taken from the main trunk and the pressure main. The results of the study indicated that H2S was not generated from slime layers on the pipe walls but was mostly produced from sediments in the main trunks and the pressure mains. The H2S production rate from the sediments ranged from 5.5 to 64 micrograms/g solid/h depending on the organic content and the cell numbers of sulfate reducing bacteria (SRB) in sediments. The limiting nutrients for the production of H2S from sediments were fatty acids. The corrosion rate in the concrete sewer pipe were found to be 3.7-7.6 mm/y from the core samples at an H2S concentration of 3-400 ppm and a temperature range of 10 and 30 C. The corrosion rates of mortar specimens were 3.7-7.6 mm/y at H2S concentrations of 25 to 300 ppm and a temperature range of 10-30 C. The maximum corrosion rates of the mortar was 36 mm/y at a temperature range of 25-30 C and at 3 to 400 ppm of H2S. It was determined that nutrients in the sewage could accelerate the corrosion of the mortar. Corroded materials found in the concrete sewer pipe and the mortar specimens were identified as gypsum and ettringite. (Korn-PTT)
W91-05734

ANAEROBIC FILTER TREATMENT OF SULFATE-CONTAINING WASTEWATERS.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
G. F. Parkin, M. A. Sneve, and H. Loos.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1283-1291, 1991. 3 fig, 5 tab, 21 ref.
Environmental Protection Agency Contract No. R-811657-01-1.

Descriptors: *Anaerobic digestion, *Anaerobic filters, *Biological wastewater treatment, *Industrial wastewater, *Sulfates, *Wastewater reactors, *Wastewater treatment, Hydrogen sulfide, Inhibition, Methane bacteria, Methanogenesis, Retention time, Sulfides, Sulfur bacteria, Toxicity.

The use of anaerobic biological processes for the treatment of industrial wastewaters has significant merit. When high levels of sulfate are present, the

sulfate is biologically reduced to sulfide, the result being potential toxicity to the consortia of organisms responsible for methane production. An upflow anaerobic filter fed propionate was used to asses the ability of such a reactor system to treat wastewaters containing high levels of sulfate. The investigation also sought to determine the levels of H2S and dissolved sulfide causing decreased process performance, and to compare the performance of the anaerobic filter to completely mixed reactor systems. Hydraulic retention times of one and two days were tested while organic loading rates were varied from 3-5 g COD/L-day and feed COD/S was varied from 24.5 to 8. Unionized hydrogen sulfide and dissolved sulfide levels associated with decreased process performance were approximately 110 mg S/L and 350 mg S/L, respectively. These levels are significantly higher than those levels causing inhibition in completely mixed reactors. Most of the sulfate reduction and propionate removal took place in the first 300 mm of the 1050-mm-long reactor, indicating that sulfate reduction and methane production were occurring in the same location in the filter. (Author's abstract)
W91-05735

PILOT PLANT STUDIES ON BIOLOGICAL SULPHATE REMOVAL FROM INDUSTRIAL EFFLUENT.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
J. P. Maree, G. Hulse, D. Dods, and C. E. Schutte.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1293-1300, 1991. 2 fig, 3 tab, 14 ref.

Descriptors: *Anaerobic digestion, *Biodegradation, *Biological wastewater treatment, *Industrial wastewater, *Microbial degradation, *Sulfates, *Sulfur bacteria, *Wastewater treatment, Acetic acid, Hydrogen sulfide, Molasses, Sugars, Wastewater reactors.

Sulfate-rich industrial effluents present a serious environmental pollution problem. A biological sulfate removal process has been developed for the treatment of such effluents. The process consists of anaerobic, stripping, and sulfur production stages. In the anaerobic stage of the process, sulfate is converted to hydrogen sulfide when an energy source, such as molasses, sugar, or a producer gas is added. The hydrogen sulfide is stripped off in a stripping stage, with a carrier gas such as nitrogen. The gas is then recycled through a ferric solution where it is oxidized to elemental sulfur. In a subsequent aerobic stage, degradation of organic carbon residuals and calcium carbonate crystallization are achieved simultaneously. The anaerobic stage of the process was evaluated on a pilot scale. After the inoculation period, sulfate was removed continuously for a period of 100 days from 2200 mg/l to below 200 mg/l. For the first part of the study acetic acid served as the energy source as the sugar content of molasses was allowed to ferment. Thereafter, fresh molasses was supplied as an energy source and the bacterial culture had to adapt to utilize the sugar in the molasses as the energy source. A volatile suspended solids (VSS) concentration of 27 g/l was present in the packing material of the anaerobic reactor. With this VSS-value, a hydraulic retention time of 12 hours was needed for sulfate removal. (Author's abstract)
W91-05736

REMOVAL OF ORGANIC CONSTITUENTS IN MUNICIPAL SEWAGE USING ANAEROBIC FLUIDIZED SLUDGE BLANKET AND ANAEROBIC FILTER.
Meisei Univ., Tokyo (Japan). Dept. of Civil Engineering.
S. Tanaka, T. Ichikawa, and T. Matsuo.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1301-1310, 1991. 7 fig, 5 tab, 5 ref.
Japanese Ministry of Education, Science and Culture Grant-in-Aid for Scientific Research No. 63850124.

Descriptors: *Anaerobic digestion, *Anaerobic filters, *Biological wastewater treatment, *Domestic wastes, *Municipal wastes, *Sludge digestion, *Wastewater reactors, *Wastewater treatment, Carbohydrates, Chemical oxygen demand, Humic acids, Lignin, Lipids, Methanogenesis, Organic matter, Proteins, Retention time, Sludge analysis, Sulfates, Surfactants, Tannins, Total organic carbon.

The removal of various organic constituents from municipal sewage was investigated using anaerobic fluidized sludge blanket (AFSB) and anaerobic filter (AF) reactors. The experiments were conducted at 37 C and hydraulic retention times (HRT) which varied between 24 and 8 hours. The municipal sludge in the AFSB reactor did not aggregate, but flocculated with the formation of a sludge blanket. Results of the experimental investigation revealed that the AFSB reactor could treat the sewage more efficiently than the AF reactor and the removal efficiency of organic matter greatly varied in constituents. At the temperature and HRTs used in the AFSB reactor experiments, there was a 50% reduction in the chemical oxygen demand (COD) and a 59% reduction in total organic carbon (TOC) content of the municipal sewage. Lipids, proteins, and carbohydrates were highly removed, but the removal efficiency of surfactants was very low under anaerobic conditions. No removals of tannin, lignin, or humic acids were observed during the experiments. Methane production was rather limited (0.12 cu m /kg COD removed at STP) with a COD removal by sulfate reduction mechanism serving as a possible explanation. The sludge production during the 272 day operation time was 0.272 g volatile suspended solids (VSS)/g COD removed in the AFSB reactor; a net sludge destruction of 68% was obtained in the AFSB reactor experiment. (Korn-PTT)
W91-05737

EFFECTS OF SUBSTRATE COMPOSITION AND LOADING RATE ON METHANOGENIC PROCESS IN ANAEROBIC FLUIDIZED BED SYSTEMS.
Sanki Engineering Corp. Ltd., Yamato (Japan). Technical Research Labs.
A. Matsumoto, and T. Noike.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1311-1317, 1991. 10 fig, 1 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Biofilm reactors, *Biological wastewater treatment, *Fluidized bed process, *Hydraulic loading, *Wastewater treatment, Biofilms, Laboratory methods, Load distribution, Methanogenesis, Substrates, Wastewater reactors.

The effects of substrate composition and high volumetric loading rates on the characteristics of substrate removal and biofilm formation in the methanogenic phase of the anaerobic two-phase digestion process were investigated by using laboratory-scale anaerobic fluidized reactors. The effect of substrate composition was studied using three kinds of substrate. The first substrate was composed of acetic acid, while the second and third were mixed-acid substrates composed of acetic acid, propionic acid, and butyric acid. A small amount of yeast extract and glucose were added to the second and third substrates, respectively. In experiments in which yeast extract or glucose was added to the mixed acid substrate, the substrate removal efficiencies were higher than those in the experiments using only the acetic acid substrate. The biofilm formation was accelerated by using the mixed substrate to which yeast extract was added. The effects of high volumetric loading rates were studied using an acetic acid substrate and a mixed acid-glucose substrate. In both cases, the chemical oxygen demand (COD) removal efficiencies of the reactors were remarkably high (e.g., over 98.5%) at a COD volumetric loading rate which ranged from 2.5 to 30 kg COD/cu m/d. However, the effluent quality of that reactor to which acetic acid was added proved to be unstable. (Author's abstract)
W91-05738

APPLICATION OF BIOFILM KINETICS TO ANAEROBIC FIXED BED REACTORS.
Technical Univ. of Istanbul (Turkey).
I. E. Gonenc, D. Orhon, and B. B. Baykal.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1319-1326, 1991. 8 fig, 13 ref.

Descriptors: *Anaerobic digestion, *Biofilm reactors, *Biological wastewater treatment, *Food-processing wastes, *Kinetics, *Wastewater treatment, Biofilms, Chemical oxygen demand, Design standards, Hydraulics, Industrial wastewater, Izmit Bay, Model studies, Operating policies, Pilot plants, Process control, Turkey, Wastewater reactors.

A recent investigation revealed that fermentation industries have been one of the major polluting sources in Izmit Bay, Turkey. In these industries different kinds of products are produced mainly by fermentation of sugar-beet molasses. In order to meet discharge standards for the bay, the anaerobic fixed bed system was selected for the treatment of the molasses wastewaters and a study was undertaken to provide design and operation procedures for the anaerobic system. The study focused on a pilot-scale investigation of process characteristics both from a fundamental and a practical standpoint. Two basic phenomena describe the soluble chemical oxygen demand (COD) removal mechanisms in anaerobic fixed bed reactors. One phenomenon concerned reactor hydraulics while the other was mass transport through biofilm coupled with kinetic expressions for substrate transformations. The results of the experimental investigation revealed that the removal of soluble organic matter in anaerobic fixed film reactors was governed by biofilm kinetics. It was demonstrated that the soluble COD removal rates led to bulk first-order reaction rates at low COD concentrations. At higher concentrations, the COD removal rates indicated bulk half-order reaction rates as a result of partial penetration of COD. In those cases when the biofilm had been completely penetrated, the COD removal rates indicated zero-order reaction rates. (Korn-PTT)
W91-05739

TRANSIENT RESPONSES OF WASTEWATER TREATMENT AND BIOMASS DEVELOPMENT IN A METHANOGENIC FLUIDIZED BED.
Kyushu Univ., Fukuoka (Japan). Dept. of Hydraulic Civil Engineering.
H. Furumai, T. Kuba, T. Imai, and T. Kusuda.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1327-1336, 1991. 10 fig, 4 tab, 21 ref.

Descriptors: *Anaerobic digestion, *Biofilm reactors, *Biological wastewater treatment, *Fluidized bed process, *Methanogenesis, *Microbial degradation, *Model studies, *Wastewater treatment, Anaerobic bacteria, Biofilms, Biomass, Experimental design, Fatty acids, Laboratory methods, Methane bacteria, Substrates, Wastewater reactors.

A study conducted was to develop a model that can describe the characteristics of anaerobic treatment in a methanogenic fluidized bed reactor under non-steady state conditions. The usefulness of the model, in which active biomass concentration is used as an index of bacteria concentration, was also evaluated. Treatment in the fluidized bed reactor started with biocoated synthetic zeolite as support material. The reactor was supplied with synthetic wastewater which was a mixture of volatile fatty acids (VFAs). Batch experiments on activity were carried out under several steady state conditions, using a kind of VFA as a substrate. The results of the experiments and simulations performed on the methanogenic fluidized bed revealed that the overall growth yields of acetogenic and methanogenic bacterial groups were estimated at about 0.05 (chemical oxygen demand (COD) cell/ COD substrate), based on COD conservation using steady state data. An experiment on response was conducted according to the stepwise changing of the influent concentration. Transient responses of water quality were evaluated in relation to the growth of bacterial groups which decompose VFAs. The transient response of substrate concentrations appeared to be the result of the growth of active biomass. Based on the results, a dynamic model was proposed, in which attached biomass is categorized into active biomass and inert organic matter. (Author's abstract)
W91-05740

FED-BATCH TECHNIQUE TO EVALUATE BIODEGRADATION RATES OF INHIBITORY COMPOUNDS WITH ANAEROBIC BIOFILMS ATTACHED TO GRANULAR ACTIVATED CARBON.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
P. Fox, and M. T. Suidan.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1337-1346, 1991. 5 fig, 3 tab, 15 ref.

Descriptors: *Adsorption kinetics, *Anaerobic digestion, *Biofilm reactors, *Biological wastewater treatment, *Inhibition, *Wastewater treatment, Biodegradation, Biomass, Experimental design, Granular activated carbon, Kinetics, Laboratory methods, Mass transport, Methanogenesis, Microbial degradation, Substrates.

Adsorption kinetics render measurements of substrate utilization rates in biofilm attached to adsorbing materials difficult. A fed-batch technique which maintains a constant concentration of substrate in the presence of biomass attached to granular activated carbon (GAC) was developed to measure biological kinetics independent of adsorption kinetics. The fed-batch technique used pre-adsorbed substrate on GAC as a source of substrate. During the experiment, the mass of substrate that is biodegraded is negligible when compared to the large mass of adsorbed substrate. Near equilibrium adsorption phenomena maintain the concentration of substrate constant throughout the experiment and eliminates mass transport resistance within the biofilms. Substrate utilization rates were measured at a specific substrate concentration by monitoring methane gas production rates. Samples of GAC with attached biomass were removed from two expanded-bed anaerobic reactors. GAC samples from a 3-ethylphenol (3-ep) fed reactor were used in batch experiments with 3-ep as the substrate and GAC samples from an orthochlorophenol (OCP) fed reactor were used in batch experiments with OCP as the substrate. Data were observed to fit Haldane kinetics and predictions from the Haldane kinetic parameters were in agreement with transient behavior from the 3-ep fed reactor. This technique was useful in predicting threshold inhibitory levels for continuous treatment of inhibitory wastewaters in expanded-bed GAC reactors. The fed-batch technique might also be applied to measure substrate utilization rates of biomass attached to other adsorbable materials such as soils. (Author's abstract)
W91-05741

STUDY OF BIOFILM AND FLUIDIZATION OF BIOPARTICLES IN A THREE-PHASE LIQUID-FLUIDIZED-BED REACTOR.

Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
F. Trinet, R. Heim, D. Amar, H. T. Chang, and B. E. Rittmann.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1347-1354, 1991. 3 fig, 1 tab, 8 ref.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Fluidized beds, *Microbial degradation, *Wastewater treatment, Correlation analysis, Hydrodynamics, Model studies, Substrates, Turbulent flow, Velocity.

The use of attached growth processes, e.g., three-phase liquid-fluidized beds, is a means of obtaining very high concentrations of bacteria. When treating wastewaters, very high concentrations of bacteria make it possible to increase the loading applied and so reduce the size of the treatment process. Using a hydrodynamic model of the three-phase liquid-fluidized bed, the study delineates relationships between the characteristics of the biofilm and the environmental conditions to which it is subject. A three-phase liquid-fluidized bed biofilm reactor was operated over a wide range of parameters, including liquid velocity, air velocity, medium concentration, and substrate surface loading. Biofilm characteristics, such as total colonization, polysaccharide content, density, and thickness, and the specific detachment coefficient (bs), were determined by a combination of experimental measurements and a hydrodynamic model. The results demonstrated that dense and thin biofilms were induced by the physical condition of high particle-to-particle contacts and high liquid turbulence, respectively. The biofilm's polysaccharide content was increased by increased air turbulence and a low substrate availability. The specific detachment coefficient, had a strong negative correlation to the concentration of the medium and a strong positive correlation to the polysaccharide content of the biofilm. Overall, the detachment coefficient can be controlled significantly by the gas and liquid velocities used in the reactor and so increasing either velocity would tend to increase specific detachment coefficient. (Author's abstract)
W91-05742

BIOFILM PROPERTIES AND SIMULTANEOUS NITRIFICATION AND DENITRIFICATION IN AEROBIC ROTATING BIOLOGICAL CONTACTORS.

Miyazaki Univ. (Japan). Dept. of Civil Engineering.
S. Masuda, Y. Watanabe, and M. Ishiguro.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1355-1363, 1991. 15 fig, 3 tab, 3 ref.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Denitrification, *Nitrification, *Wastewater treatment, Aerobic digestion, Ammonia, Bacteria, Microbial degradation, Microbiological studies, Nitrogen removal, Retention time, Wastewater reactors, Water temperature.

The properties of a biofilm, such as the spatial distribution of biofilm density, bacterial population, and intrinsic biochemical rates, were determined for a rotating biological contactor (RBC) system. In order to measure biofilm properties, thin slices were made of the biofilm using a micro-slicer. The slices were then divided into three groups, depending on their appearance, and density, bacterial population, and intrinsic biochemical reaction rate measurements were made. A series of experiments were conducted to discover the factors influencing the simultaneous nitrification and denitrification using a covered RBC in which the oxygen pressure was controlled between approximately 0.2 and 0.05 atms. The results of the investigation revealed that the biofilm density and the number of heterotrophs, nitrifiers, and denitrifiers, per unit volume of biofilm increased with biofilm depth. However, the intrinsic reaction rates per unit biomass did not significantly change with depth. The experimental results demonstrated that nitrogen removal efficiency in an aerobic RBC depends on the oxygen partial pressure in the air phase, water temperature, hydraulic detention time and ratio of the influent concentration of organics to ammonia nitrogen. (Korn-PTT)
W91-05743

SIGNIFICANCE OF SPATIAL DISTRIBUTION OF MICROBIAL SPECIES IN MIXED CULTURE BIOFILMS.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
M. Fruhen, E. Christan, W. Gujer, and O. Wanner.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1365-1374, 1991. 7 fig, 9 ref, append.

Descriptors: *Bacteria, *Biofilm reactors, *Biofilms, *Microbial degradation, *Microbiological studies, *Model studies, *Wastewater treatment, Bacterial analysis, Denitrification, Experimental design, Heterotrophic bacteria, Laboratory methods, Nitrification, Population dynamics, Spatial distribution, Substrates.

The concentrations of dissolved organic substrates may drastically change over the depth of a biofilm. Thus, it has to be expected that the population which develops in the depth of a mixed culture biofilm also differs from that near the biofilm surface. While there are experimental observations which reveal a nonuniform spatial distribution of microbial species, most biofilm models assume a uniform microbial distribution. A current study was conducted to obtain experimental data from a biofilm reactor in which groups of nitrifiers and heterotrophs competed for dissolved oxygen. First a biofilm of known spatial composition of heterotrophic and autotrophic biomass was grown in a laboratory reactor. The development of the microbial composition was examined indirectly by measuring the nitrification rate under various experimental conditions. The experimental results were then analyzed using a Mixed Culture Biofilm Model. The results showed that within nine days the nitrification rate in a biofilm of constant thickness could change by a factor of five. Model predictions indicated that these changes must be due to a significant shift of the biofilm population. The distribution of the autotrophic and heterotrophic species over the depth of the biofilm turned out to be an important aspect of mixed culture biofilm behavior. (Korn-PTT)
W91-05744

BIODEGRADATION KINETICS OF PHENOLS IN AN AEROBIC BIOFILM AT LOW CONCENTRATIONS.

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E. Arvin, B. K. Jensen, and A. T. Gundersen.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1375-1384, 1991. 8 fig, 1 tab, 16 ref.

Descriptors: *Aerobic digestion, *Biodegradation, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Kinetics, *Phenols, *Wastewater treatment, Aerobic biofilm, Aerobic treatment, Biomass, Experimental data, Experimental design, Industrial wastewater, Inhibition, Monod term, Substrates.

Aerobic biodegradation of the phenols: 2-methylphenol, 4-methylphenol, 2,4-dimethylphenol, 3,5-dimethylphenol, and 2,4,6-trimethylphenol was studied in a biofilm reactor to establish kinetic constants under conditions where the phenols were the sole carbon source. In the experiments, phenol concentrations were very low (microgram/l range). The results of the experiments revealed that while 2,4,6-trimethylphenol had not been degraded, the degradation kinetics of the other phenols was first order at concentrations in the bulk phase below 20-50 micrograms/l. At bulk phase concentrations above 200 microgram/l, zero order reaction kinetics predominated. The first order rate constants calculated from the experimental data were 3-30 times higher than the constants calculated for organic compounds degraded at 100-1000 times higher bulk phase concentrations (mg/l range). However, the maximum phenol utilization rates and the Monod constants were much lower when compared with constants obtained for microorganisms grown in the mg/l concentration range with the Monod constant being about 100 times lower. The removal of total biodegradable phenol (TB-phenol) was very similar to the removal of a specific compound. The degradation of TB-phenol was first order at concentrations below 200 micrograms/l. When TB-phenol was near its maximum capacity (i.e., zero order reaction) there was a preferential degradation of the most easily degradable phenols (phenol and 2-methylphenol), leading to an apparent inhibition of the degradation of the more slowly degradable phenols, in particular, 2,4-dimethylphenol and 3,5-dimethylphenol. (Author's abstract)
W91-05745

ANAEROBIC TREATMENT OF A HIGH-STRENGTH INDUSTRIAL WASTE BEARING INHIBITORY CONCENTRATIONS OF 1,1,1-TRICHLOROETHANE.

Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
M. T. Suidan, A. M. Wuellner, and T. K. Boyer.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1385-1393, 1991. 8 fig, 3 tab, 18 ref.

Descriptors: *Anaerobic digestion, *Biodegradation, *Biological wastewater treatment, *Chlorinated hydrocarbons, *Granular activated carbon, *Industrial wastewater, *Wastewater reactors, *Wastewater treatment, Acetates, Adsorption, Inhibition, Methane, Methane bacteria, Methanogenesis, Microbial degradation, Microbiological studies, Phenols, Trichloroethanes.

There is a growing concern over the discharge of industrial waste streams to the environment. Industrial wastewaters containing chlorinated hydrocarbons cause contamination of receiving water bodies and pose a threat to human health. The effectiveness of the expanded-bed granular activated carbon (GAC) anaerobic reactor in treating industrial wastewaters was evaluated. The industrial wastewater synthesized for experimental evaluation contained 5900 mg/L of acetic acid, 3000 mg/L of phenol, and 20-430 mg/L of 1,1,1-trichloroethane (TCA). The results of the investigation revealed that the acetic acid and phenol removal efficiencies were always better than 93 and 99%, respectively. The TCA reduction rate was always better than 99.4%. The adsorptive capacity of GAC improved the performance efficiency of the system but was not necessary for the successful operation of the reactor. Acetate and phenol biodegradation was inhibited by TCA, with a stronger effect observed on the methanogens. The treatment system tolerated moderate fluctuations in the feed concentration of TCA. (Korn-PTT)
W91-05746

PENETRATION OF BIOCIDES INTO BIOFILM.
Kurita Water Industries Ltd., Atsugi (Japan).
H. Tashiro, T. Numakura, S. Nishikawa, and Y. Miyaji.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1395-1403, 1991. 12 fig, 2 tab, 10 ref.

Descriptors: *Biocides, *Biodegradation, *Biofilms, *Biological wastewater treatment, *Diffusion, *Wastewater treatment, Bacterial analysis, Escherichia coli, Experimental data, Experimental design, Inhibition, Slime.

Recent investigations have revealed that the bacteria in biofilms are protected, to a marked extent, from the bactericidal action of various biocides. The possible penetration mechanisms of three biocides into biofilm formed on the surface of polyvinyl chloride (PVC) tubing were examined. It was determined that penetration depths of the three biocides into biofilm reached a steady state in 2 hours or less. Penetration depths at the steady-state were dependent on external concentrations of the biocides in the fluids. The results of the experiments suggested that penetration of the biocides into biofilm depended on the diffusion of biocide molecules into biofilm and the continuous consumption of biocide within the biofilm. Bacterial growth appeared to be inhibited regardless of cell densities supporting the assumption that the biocides are decomposed or inactivated by bacteria. Penetration depth was limited by decomposition of the biocides by biofilm, and the decomposing abilities were maintained even in the killed bacteria. (Korn-PTT)
W91-05747

PHOSPHATE REMOVAL IN A BIOFILM REACTOR.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
S. Gonzalez-Martinez, and P. A. Wilderer.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1405-1415, 1991. 8 fig, 5 tab, 19 ref.

Descriptors: *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Nutrient removal, *Phosphorus removal, *Wastewater treatment, Aerobic degradation, Anaerobic degradation, Biodegradation, Biomass, Laboratory methods, Microbial degradation, Microbiological studies, Phosphates, Substrates.

Biological phosphate (P) removal systems have become important over the past years because nutrient removal can be achieved without the need of adding chemicals to the water. A study evaluated the performance of a laboratory-scale fixed bed biofilm reactor, employing a sequencing batch reactor (SBR) strategy as a phosphate removal system. The reactor was seeded with activated sludge taken from wastewater treatment plants. To create the conditions required for enrichment of phosphate-accumulating bacteria, the reactor was periodically filled and drained using synthetic wastewater, and the aerator periodically turned on and off (i.e., SRB strategy). The reactor performed very effectively, but it took several weeks to reach steady-state conditions. The highest phosphate uptake rates were observed when sequestration of the organic substrates was accomplished at an early stage of the anaerobic process phase, and release of phosphate at the expense of sequestered or stored substrates (endogenous phosphate release) was encouraged. Temperature, which ranged between 15 and 25 C, appeared to affect the rate of P release and P uptake, but had no significant effects on the overall P removal efficiencies of the experimental system. The microbial system responded very differently to the organic compounds of the synthetic wastewater when one of these compounds was intermittently fed as the only carbon source. It was determined that a direct stoichiometry occurred between anaerobic peptone or acetate uptake and P release. However, glucose uptake occurred much more rapidly than the accompanying P release, indicating that glucose uptake was not directly coupled with storage of glucose carbon. (Korn-PTT)
W91-05748

NITRIFICATION AND DENITRIFICATION OF HIGH-STRENGTH AMMONIUM AND NITRITE WASTEWATER WITH BIOFILM REACTORS.
National Cheng Kung Univ., Tainan (Taiwan). Dept. of Environmental Engineering.
S. K. Chen, C. K. Juaw, and S. S. Cheng.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1417-1425, 1991. 7 fig, 1 tab, 23 ref.
National Science Council, Republic of China Contract No. NSC 75-0410-E006-38Z.

Descriptors: *Ammonium, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Denitrification, *Fluidized bed process, *Microbial degradation, *Nitrification, *Nitrites, *Nitrogen removal, *Wastewater treatment, Biodegradation, Wastewater reactors.

A study was conducted in which two sets of fixed-film biological processes were operated separately for nitritification of ammonium and for denitritification of nitrite associated with organic compounds. The experimental data revealed that high strength ammonium wastewater (50-1000 mg NH4(+)-N/l) could be effectively nitritified by a draft-tube fluidized bed which was operated at an extremely high loading of 1.0 kg NH4(+)-N/m3.day with 95% ammonium conversion and 60 to 95% nitrite formation. Additionally, a biofilm fixed-bed was employed to denitritify the high strength nitrite (200 to 1000 mg NO2(-)-N/l) associated with organic compounds of glucose, acetate, and benzoic acid. Complete nitrite removal could be achieved with sufficient hydraulic retention times (HRT) and chemical oxygen demand (COD)/NO2(-)-N ratio. The conversion ratios were estimated experimentally at 2.5 for glucose and acetate, and 2.0 g delta COD/g delta NO2(-)-N for benzoic acid. It is proposed that an aerobic nitritifying biofilm reactor combined with an anoxic denitritifying biofilm reactor in series could be employed for complete nitrogen removal. (Author's abstract)
W91-05749

LARGE SCALE ANAEROBIC-AEROBIC TREATMENT OF COMPLEX INDUSTRIAL WASTE WATER USING BIOFILM REACTORS.
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J. J. Heijnen, A. Mulder, R. Weltevrede, J. Hols, and H. L. J. M. van Leeuwen.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1427-1436, 1991. 13 fig, 5, tab, 9 ref.

Descriptors: *Aerobic digestion, *Anaerobic digestion, *Biodegradation, *Biofilm reactors, *Biofilms, *Biological wastewater treatment, *Biomass, *Industrial wastewater, *Wastewater treatment, Ammonia removal, Ammonium, Biogas, Fluidized bed process, Fluidized beds, Hydrogen sulfide, Wastewater reactors.

Warm concentrated industrial wastewaters are preferably treated in an anaerobic reactor for reasons of energy generation and low surplus sludge production. However, there are problems to be solved in the practical application of the technology. These problems include a low growth rate of the microorganisms, their low settling rate process instability, and the need for after-treatment of the noxious anaerobic effluent which often contains NH4(+) and HS(-). An investigation was undertaken to determine the use of biomass immobilized on small suspended carriers as a suitable means to overcome these problems. Research at Gist-brocades, Delft, The Netherlands, led to the construction of a full scale plant which utilized an anaerobic pretreatment process and an aerobic posttreatment process. The anaerobic pretreatment process used a liquid/solid fluidized bed as the reactor. Results revealed that the anaerobic fluidized bed system offered an acceptable alternative in that the process enabled a good anaerobic treatment at high loads and short liquid residence times for a normal load. The aerobic posttreatment system consisted of an aerobic airlift suspension reactor. The use of this system has shown the process to be efficient for high rate aerobic purification. High biomass concentrations and purification capacities in a difficult wastewater were possible to achieve. (Korn-PTT)
W91-05750

BIOLOGICAL OXIDATION OF FERROUS IRON IN HIGH ACID MINE DRAINAGE BY FLUIDIZED BED REACTOR.
Iwate Univ., Morioka (Japan). Dept. of Civil Engineering.
T. Omura, T. Umita, V. Nenov, J. Aizawa, and M. Onuma.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1447-1456, 1991. 16 fig, 2 tab, 8 ref.

Descriptors: *Acid mine drainage, *Biological oxidation, *Biological wastewater treatment, *Fluidized bed process, *Iron bacteria, *Wastewater treatment, Biodegradation, Dissolved oxygen, Experimental design, Hydrogen ion concentration, Iron, Mine drainage, Model studies, Temperature effects.

Acid mine drainage is usually highly acidic and contains a large amount of ferrous iron formed naturally by dissolution of metal sulfides through biological and chemical reactions. One of the treatment processes for this mine drainage involves the biological oxidation of ferrous iron to ferric iron by iron oxidizing bacteria. An investigation was conducted in which the biological oxidation of iron was studied both in batch experiments and in fluidized bed reactor with Amberlite IRA-938 as a support medium. Results from the batch experiments revealed that the effects of the initial ferrous iron and dissolved oxygen concentrations on the specific rate of ferrous iron oxidation could be expressed by a Monod type equation. The fluidized bed reactor achieved ferrous iron oxidation of > 90% within the flow rate range of 0.75 l/h to 4.5 l/h. The ferrous iron oxidation in the fluidized bed reactor did not appear to be influenced, to any great degree, by the change in the water temperature. To avoid the problem of clogging by ferric hydroxide, it was recommended that the fluidized bed reactor be operated such that the influent pH is not more than 2.0. A proposed mathematical model describing the behavior of ferrous iron concentration in the fluidized bed reactor was very useful for predicting the effluent ferrous iron concentration under both steady and nonsteady state conditions. (Author's abstract)
W91-05752

PERFORMANCE ANALYSIS OF THE ROTATING BIOLOGICAL CONTACTOR PROCESS BASED ON PARTICLE FRACTION AND IMPROVEMENT OF FINAL EFFLUENT QUALITY.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
K. Tanaka, M. Tada, M. Ito, and N. Shimizu.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1457-1466, 1991. 9 fig, 2 tab, 2 ref.

Descriptors: *Biofilms, *Biological wastewater treatment, *Particle size, *Suspended solids, *Transparency, *Wastewater treatment, Biofilm reactors, Biological oxygen demand, Clarification, Coagulation, Filtration.

Biofilm processes are, in general, suitable for small-scale wastewater treatment plants. However, final effluent qualities of biofilm processes are not as good as those of activated sludge processes due to fine particles remaining in the effluents. To improve the effluent qualities of the Rotating Biological Contactor (RBC) process, the behavior of fine particles through the process and the removal of fine particles with solids-liquid separation methods, rapid filtration, and coagulation-filtration, were investigated using the particle fraction method. An increase of the hydraulic retention time (HRT) in the RBC reactor reduced the amount of fine particles and increased the amount of coarse suspended solids of 44 micrometers or more in diameter, which are easily removed by clarification. Thus, the final effluent qualities were improved by the increase of HRT. Suspended solids in effluent from the RBC process at the standard loading are so fine that improvement of the quality is not expected by only lowering the overflow rate of a final clarifier. In contrast, rapid filtration or a coagulation-filtration process is effective. The suspended solid concentration and transparency of the effluent from the final clarifier was improved by a factor of two to four, and the biological oxygen demand (BOD) of the final effluent was removed by 40-85%. (Author's abstract)
W91-05753

PERFORMANCE EVALUATION OF COMPACT RBC-SETTLING TANK SYSTEM.
Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Environmental Engineering Lab.
K. H. Ahn, and J. S. Chang.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1467-1476, 1991. 13 fig, 4 tab, 10 ref.

Descriptors: *Biological wastewater treatment, *Domestic wastes, *Nitrogen removal, *Sludge treatment, *Wastewater reactors, *Wastewater treatment, Ammonia, Biomass, Hydraulic loading, Organic loading, Sludge, Suspended solids.

A laboratory study was conducted to investigate the performance of a rotating biological contactor(RBC)-settling tank system on wastewater treatment in comparison with conventional RBC. The same synthetic wastewater was fed parallel into four stage laboratory scale cascade-connected RBC-settling tank and conventional RBC reactors at a fixed rotational speed and hydraulic loading. At three different organic loading rates of 6.14, 13.44, and 23.31 g soluble chemical oxygen demand (SCOD)/sq m/d, the results of the systems are presented in terms of ammonia nitrogen (NH3-N), total kjeldahl nitrogen (TKN), organic and suspended solids (SS) loading and removal. Disk biomass index (DBI), sludge biomass index (SBI), and fractional biomass volatile solids destruction (FBVSD) were used to compare the disk active biomass and the sludge stability of the RBC-settling tank system with those of the conventional RBC. Removal efficiency of SS, NH3-N, and TKN was much higher in the RBC-settling tank system than the conventional RBC. However, organic removal, in terms of g SCOD removed/sq m/d of both reactors was not much different. Much better sludge stabilization was observed in the RBC-settling tank system. Because the RBC-settling tank system performed very well overall, it may be an effective and economical system for treating domestic wastewater in small and isolated communities. (Author's abstract)
W91-05754

DENITRIFICATION OF LANDFILL LEACHATE BY THE MODIFIED ROTATING BIOLOGICAL CONTACTOR (RBC).
National Inst. for Environmental Studies, Tsukuba (Japan).
M. Hosomi, I. Yuhei, K. Matsushige, and R. Sudo.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1477-1485, 1991. 2 fig, 10 tab, 11 ref.

Descriptors: *Anaerobic filters, *Biological filters, *Landfills, *Leachates, *Nitrogen removal, *Sludge disposal, *Wastewater treatment, *Water pollution prevention, Biological oxygen demand, Denitrification, Nitrification, Organic compounds, Organic loading.

In order to simultaneously remove high-strength nitrogen and organics from a landfill leachate, a modified rotating biological contactor (RBC) was developed. The modified RBC contained an anaerobic biofilter which was packed with special string media and was then incorporated into a standard RBC. The leachate used in the investigation was taken from a co-disposal site for sewage sludge and municipal solid waste. The biological oxygen demand (BOD) surface loading of the rotating disks was varied from 2 to 10 g/sq m/d while the rotating rate of the disks ranged from 8 to 32 rpm. The capability to remove chemical oxygen demand (COD) containing refractory organic compounds was much greater in the modified RBC than in the standard RBC. Nitrogen removal in the modified RBC was about 90% compared to 50% in the standard RBC. The modified RBC had the advantage of nitrogen removal because nitrification and denitrification proceeded efficiently, even when a carbon source was not added. Finally, the performance of the modified RBC was superior to that of the standard RBC in both BOD surface loading and BOD volumetric loading. (Korn-PTT)
W91-05755

EFFECT OF SHORT-TERM AND LONG-TERM CHANGES IN HYDRAULIC CONDITIONS ON NITRIFYING BIOFILM.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
S. Kugaprasatham, H. Nagaoka, and S. Ohgaki.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1487-1494, 1991. 6 fig, 2 tab, 6 ref.

Descriptors: *Biofilms, *Biomass, *Laboratory methods, *Substrates, *Wastewater treatment, *Water treatment, Bacteria, Microbiological studies, Model studies, Turbulent flow.

One of the important applications of biofilm processes is the removal of pollutants found at very low concentrations in water and wastewater systems. At low concentrations, the amount of biofilm biomass is very small and hydraulic conditions become an important factor affecting the biofilm's performance. The effects of hydraulic conditions on nitrifying biofilms grown under substrate-limiting conditions was investigated using a laboratory scale cylindrical reactor. The nitrifying biofilm was grown on the wall of the reactor at a base hydraulic condition with an average turbulent intensity of 6.6 cm/s. Specific fluxes measured at the end of short time periods for changed turbulent intensities varied according to a power law with a coefficient of 0.76 up to a turbulent intensity of 1.3 cm/s. This value was in agreement with the theoretical expression derived for filamentous biofilms under turbulent conditions. However, further reduction of turbulent intensity did not decrease the specific flux. These findings indicated the existence of molecular-type diffusion under low turbulent intensities. Long-term changes in hydraulic conditions (i.e., decreases) decreased the specific flux showing substrate transfer limitations. An examination of the nature of the biofilms biomass indicated that filamentous-type biofilms were observed at high velocities and turbulent intensities while colony-type biofilms were found under low velocities and turbulent intensities. (Korn-PTT)
W91-05756

SHOULD WASTE STABILIZATION PONDS BE DESIGNED FOR PERFECT-MIXING OR PLUG-FLOW.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
M. Juanico.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1495-1502, 1991. 4 fig, 2 tab, 15 ref.

Descriptors: *Flow pattern, *Model studies, *Plug flow, *Stabilization ponds, *Wastewater treatment, Bacteria, Biological oxygen demand, Effluents, Hydraulic loading.

The effect of the hydraulic flow pattern on the performance of waste stabilization ponds (WSP) was analyzed by modelling two parameters with different removal constants (i.e., bacteria and biological oxygen demand (BOD)). The analysis was made for cases of steady hydraulic loading and hydraulic loading changes occurring on weekends. The results of the modelling exercises revealed that plug-flow ponds performed much better than perfect mixed ponds for removal of parameters with high removal constants such as bacteria. Changes in the hydraulic loading regime, due to weekend effects, did not modify the variability of outflow quality from plug-flow ponds. The plug-flow and perfect mixed ponds performed very similarly when the removal constant was low, as for BOD. However, the changes in hydraulic loading did affect the variability of outflow quality from perfect mixed ponds only in the case of parameters with high removal constants, such as bacteria. Further implications of the current modelling investigation revealed that polishing ponds, intended for bacterial removal, should be designed for a flow pattern similar to plug-flow. In addition, facultative ponds intended for BOD removal may be designed for perfect mixed, partial mixed, or plug-flow. It was envisioned that several small ponds with short residence times, located in series, could avoid short circuiting of effluents between inlet and outlet. However, this design did not assure a plug-flow pattern, and it could lead to the formation of dead areas and the reduction of the actual residence time of effluents within the system. (Author's abstract)
W91-05757

APPLICATION OF THREE STEP-BIOLOGICAL POND WITH THE USE OF AQUATIC PLANT FOR POST TREATMENT OF PETROLEUM WASTEWATER IN VIETNAM.
Ho Chi Minh City Polytechnic (Vietnam). Dept. of Environmental Engineering.
L. M. Triet, N. T. Viet, T. V. Thinh, H. D. Cuong, and J. C. L. van Buuren.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1503-1507, 1991. 5 fig, 2 tab, 4 ref.

Descriptors: *Chlorella, *Industrial wastewater, *Oil wastes, *Reeds, *Stabilization ponds, *Waste stabilization, *Wastewater treatment, *Water hyacinth, Activated sludge process, Biodegradation, Effluents, Oil industry, Vietnam, Wastewater, Wastewater pollution.

Wastewater pollution is a serious problem in Vietnam where, currently, domestic and industrial wastewaters are discharged directly into water courses without any treatment. It has recently been decided that all new industrial facilities will install their own wastewater treatment plants. The current study focuses on the potential wastewater treatment system for a petroleum refinery plant in Vietnam. The effluent from the activated sludge treatment of the petroleum wastewater was treated with the aid of a ponding system. The system consisted of a 3 step biological pond which used three kinds of aquatic plants. The first step used the water hyacinth, the second step used Chlorella, while the third step used reeds. Results of the investigation revealed that the purification efficiency of the pilot pond system depended on a residence time of approximately 14 days. The purification of the petroleum wastewater was based on breakdown by microorganisms. Petroleum removal ranged between 97-98%, while the chemical oxygen demand (COD) removal was 88-93%. In the pond using Chlorella, the amount of dissolved oxygen increased from 0.7 mg/l to 9.8 mg/l and the pH increased from 6.9 to 8-8.6. It was determined that the aquatic plants functioned well by providing attachment sites for the organisms, producing dissolved oxygen, and consuming the nutrients supplied to the ponds. (Korn-PTT)
W91-05758

PERFORMANCE OF STABILIZATION RESERVOIRS AS A FUNCTION OF DESIGN AND OPERATION PARAMETERS.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water

Resources Engineering.
M. Juanico, and G. Shelef.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1509-1516, 1991. 4 fig, 3 tab, 4 ref.

Descriptors: *Irrigation water, *Model studies, *Stabilization ponds, *Wastewater irrigation, *Wastewater renovation, *Wastewater treatment, *Water reuse, Biological oxygen demand, Chemical oxygen demand, Effluents, Israel, Reservoirs, Seasonal variation.

Stabilization reservoirs were initially developed for the treatment and storage of wastewater used for agricultural irrigation. However, the additional stabilization that they could provide to effluents became evident. The current study formulates equations for biological oxygen demand (BOD) and chemical oxygen demand (COD) removal in these stabilization reservoirs. The removal of BOD and COD was high (i.e., 50 to 85%) in terms of annual means, but sharply changed during the year. Three models were developed to predict BOD and COD removals as a function of design and operation parameters. Input for the models was provided by the large amount of data available from four different reservoirs. The results of the modelling study revealed that the percentage of fresh effluents within the reservoir had a negative effect on BOD and COD removals. High water levels, and their concomitant low area/volume relationships, also had a negative effect on removal efficiency due to poor oxygenation of the water column. The percentage of fresh effluents within the system was a hydraulic parameter used to analyze the performance of non-steady state wastewater treatment systems. Based on that parameter, the quality of the effluents released for irrigation from the reservoirs deteriorated during the second half of the irrigation season. This deterioration was due to both the increase in the percentage of fresh effluents within the reservoir, and the occurrence of dead areas and short-circuiting phenomenon at low water levels. These problems must be resolved by proper design and operation of the reservoirs in order to obtain a more homogeneous effluent quality throughout the irrigation season. (Author's abstract)
W91-05759

MICROBIOLOGICAL PERFORMANCE OF MULTI-STAGE STABILIZATION PONDS FOR EFFLUENT USE IN AGRICULTURE.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
M. M. Saqqar, and M. B. Pescod.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1517-1524, 1991. 6 fig, 5 tab, 16 ref.

Descriptors: *Agricultural water, *Fecal coliforms, *Helminths, *Nematodes, *Stabilization ponds, *Wastewater irrigation, *Wastewater renovation, *Wastewater treatment, *Wastewater use, *Water use, Biological oxygen demand, Databases, Effluents, Hydrogen ion concentration, Jordan, Organic loading, Regression analysis, Retention time, Wastewater.

A study was conducted on total and fecal coliform removal and on intestinal nematode egg removal achieved in the Al-Samra stabilization ponds in Jordan during the period December 1986 through March 1987. The Al-Samra treatment plant consists of three almost identical parallel trains, each containing ten ponds in series. The results of the investigation revealed that a complete removal of nematode eggs was achieved for a total retention time of 34 days in the pond series. However, during that same period, the treatment plant was unable to meet World Health Organization (WHO) guidelines for the removal of fecal coliforms. Part of the reason the plant was unable to meet the guidelines could be the high organic loading rates which occur along the pond series. The anaerobic influent wastewater, with high concentrations of ammonia-nitrogen and sulfide, adversely affected algal activity and changes in pH values in the ponds. An initial linear regression analysis performed on the data indicated that retention time, pond biological oxygen demand (BOD)5 concentration, pH, and depth had a significant effect on the rate of fecal coliform die-off. While the rate of pond organic loading seemed to have less of an influence on the treatment process, it was apparent that there were interactions among several of the parameters. A multiple regression analysis is being applied to a more extensive data set than that presented here and should illustrate the relative importance of the various parameters. (Korn-PTT)
W91-05760

BACTERIAL (TOTAL COLIFORM) DIE-OFF IN MATURATION PONDS.
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
D. Qin, P. J. Bliss, D. Barnes, and P. A. Fitzgerald.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1525-1534, 1991. 3 fig, 5 tab, 12 ref.

Descriptors: *Correlation analysis, *Kinetics, *Model studies, *Stabilization ponds, *Wastewater treatment, Australia, Bacterial analysis, Coliforms, Effluents, Experimental data, Experimental design, Ponds, Temperature effects.

The bacteriology of maturation ponds has not been explored sufficiently to provide a basis for an understanding of the fundamental factors affecting bacterial die-off. The current study focuses on the main parameters affecting the removal of total coliform and evaluates the kinetics of bacterial die-off. The investigation was divided into three phases which included static tests, a mathematical model, and dynamic laboratory pilot scale pond experiments. The mathematical model of total coliform die-off in maturation ponds was developed based on first order kinetics. Laboratory single factor and dynamic model pond tests were carried out using effluent from a municipal trickling filter wastewater treatment plant. Results of the investigation revealed correlations between two groups of factors which have a significant effect on the first order rate coefficient. These two groups included environmental factors (i.e., temperature, pH, and organic loading) and illumination-related factors (i.e., sunlight intensity, depth, algal concentration, and turbidity). These correlations were used in the model along with the physical configuration factors (i.e., dimensions, detention time, and dispersion number) and a calibrated dispersion model. Predictions of the bacterial die-off using the model agreed well with experimental results obtained from the dynamic model pond tests. (Author's abstract)
W91-05761

NUTRIENT REMOVAL BY HIGH RATE POND SYSTEM IN A MEDITERRANEAN CLIMATE (FRANCE).
Montpellier-2 Univ. (France).
B. Picot, H. El Halouani, C. Casellas, S. Moersidik, and J. Bontoux.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1535-1541, 1991. 6 fig, 1 tab, 10 ref.

Descriptors: *Detention time, *Light intensity, *Marine climates, *Ponds, *Stabilization ponds, *Temperature effects, *Wastewater treatment, *Water pollution prevention, Algae, Ammonia, Domestic wastewaters, Eutrophication, Nitrogen removal, Oxidation ponds, Phosphorus removal, Photosynthesis, Seasonal variation.

A study was conducted to ascertain the mechanisms involved in nitrogen and phosphorus removal from wastewater and to determine the most effective treatment conditions for removing these nutrients by high rate ponding (HRP) in a Mediterranean climate. The HRP system favors algal production and assures satisfactory treatment of domestic wastewater. Tests carried out in Meze (France) showed that variations of climatic factors (i.e., light and temperature) can be compensated by changes in detention times. During the winter, when there was low light intensity and low temperatures, the pond was operated with long detention times (8 days). The pond was operated for short detention times in the summer when the climatic conditions were more favorable. The results of the investigation revealed that the rates of NH4-N and PO4-P removal were high and stable (i.e., 94 and 71%, respectively) during the study period February to September, 1988. Several phenomenon were believed to be responsible for nutrient elimination in the HRP. In addition to photosynthetic assimilation, the volatilization of ammonia was also thought to be responsible for nutrient removal. The precipitation of calcium phosphate, due to the high pH obtained by intense algal photosynthetic activity was also believed to play a role in the removal of nitrogen and phosphorus from the wastewaters. Wastewater treatment by HRP appears to be an attractive technique for preventing eutrophication in receiving waters. (Author's abstract)
W91-05762

PERFORMANCE OF AN INTEGRATED PONDING SYSTEM OPERATED IN ARID ZONES.
Kuwait Inst. for Scientific Research, Safat. Dept. of Biotechnology.
K. Puskas, I. I. Esen, I. Banat, and R. Al-Daher.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1543-1552, 1991. 3 fig, 5 tab, 8 ref.

Descriptors: *Agricultural water, *Arid climates, *Biological wastewater treatment, *Irrigation water, *Oxidation ponds, *Stabilization ponds, *Wastewater facilities, *Wastewater treatment, *Water reuse, Algae, Bacteria, Biological oxygen demand, Biomass, Chemical oxygen demand, Coliforms, Disinfection, Experimental design, Kuwait, Pilot plants.

A research project was conducted to develop a ponding system for municipal wastewater treatment adapted to arid regions. High-rate algal ponds preceded by facultative ponds create a combined biological system that can provide treated effluent suitable for landscape irrigation or, if upgraded, agricultural irrigation. The system can also provide algae for soil conditioning or animal feed. A pilot plant was designed and constructed to study the operation and performance of the system. An intensive experimental program was introduced with in-situ measurements of the daily pond conditions and laboratory analysis of the pond effluents to evaluate the system and determine the design parameters. The algal-bacterial ponding system performed satisfactorily providing treated effluent with less than 20 mg/l biological oxygen demand (BOD), 130 mg/l chemical oxygen demand (COD), 40 mg/l total nitrogen, and 25 mg/l NH3N. The average production of algal biomass was 250 kg/ha.d. Proper disinfection was achieved, as indicated by the average bacterial count of 5 N/ml total coliforms and 1000 N/ml total bacteria. The areas's seasonal weather variations, dense wastewater and fluctuating organic and hydraulic load, did not adversely effect the system. The pilot operation proved the advantages and efficiency of the algal-bacterial pond system in arid regions. (Author's abstract)
W91-05763

PREDICTIONS OF DIURNAL FLUCTUATIONS IN AN ALGAL BACTERIAL CLAY WASTEWATER TREATMENT SYSTEM.
Delaware Univ., Newark. Dept. of Civil Engineering.
J. B. Carberry, and C. M. Brunner.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1553-1561, 1991. 12 fig, 4 tab, 16 ref.

Descriptors: *Biodegradation, *Biological wastewater treatment, *Diurnal variation, *Model studies, *Wastewater treatment, Algae, Bacteria, Biomass, Carbon dioxide, Chemical oxygen demand, Dissolved oxygen, Hydrogen ion concentration, Microbial degradation, Microbiological studies, Oxidation-reduction potential, Photosynthesis, Substrates.

A series of experiments were conducted to investigate the effect of diurnal fluctuations and the magnitude of resulting O2, CO2, and pH oscillations for an algal bacterial clay treatment process. The experiments were performed in a biostat using different combinations of algae, bacteria, and substrate at various concentrations. The results of the experiments indicated that CO2 decreased and O2 increased during light periods due to photosynthesizing algae. The levels of CO2 increased and O2

decreased during dark periods due to respiration by both algae and bacteria. The pH fluctuated opposite to CO2 fluctuations. However, pH values less than 5 caused system failure due to a continuing decrease in algal concentration. The redox potential reached a minimum at low dissolved oxygen (DO) and then increased and leveled out at a value above zero. The level of chemical oxygen demand (COD) overrode the usual diurnal effect of light on the algal-bacterial interactions. Data from the experiments were used to develop two models that could predict changes in these parameters over a 24-hour period. One model, incorporating changes in redox potential, appeared to be more sensitive to changes in the aqueous environment than the other model, which was based on changes in COD and light fluctuations. However, both models appeared accurate at predicting the timing of changes in the measured parameters as well as predicting the algal biomass generated. (Korn-PTT)
W91-05764

NUTRIENT REMOVAL FROM AERATED LAGOONS USING ALUM AND FERRIC CHLORIDE-A CASE STUDY.
Sherbrooke Univ. (Quebec). Dept. of Civil Engineering.
K. S. Narasiah, C. Morasse, and J. Lemay.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1563-1572, 1991. 6 fig, 5 tab, 8 ref.

Descriptors: *Aerated lagoons, *Alum, *Chemical coagulation, *Nutrient removal, *Phosphates, *Phosphorus removal, *Secondary wastewater treatment, *Wastewater treatment, Chemical precipitation, Domestic wastes, Effluents, Eutrophication, Flocculation, Hydrogen ion concentration, Iron compounds, Physicochemical treatment, Seasonal variation.

The presence of phosphorus in wastewater effluent can trigger eutrophication in the receiving body of water. Therefore, wastewater treatment plants must be able to control nutrient output. A series of laboratory and on-site studies were conducted over a period of one year on an existing aerated lagoon treatment plant treating domestic wastes. The main objective of the investigation was the removal of phosphate from the effluent using alum and ferric chloride as coagulants. Simple relationships linking coagulant dosage to phosphate removal were established. It was confirmed during the study that alum reacts preferentially with polyphosphates and not with orthophosphates in the precipitation process. Seasonal temperature variations did not appear to affect the coagulation and flocculation process adversely. The molar capacity of alum for precipitating the orthophosphate fraction was greater at the secondary level of treatment compared with that at the primary level. For low concentrations of filterable phosphates, ferric chloride served as a better coagulant than alum. Overall, the phosphorus removal efficiency varied between 90 and 95% in the case of both coagulants. However, a necessary precondition for precipitation was an optimal pH value. (Korn-PTT)
W91-05765

JAPAN'S AQUA RENAISSANCE 90 PROJECT.
Tokyo Univ. (Japan). Dept. of Chemical Engineering.
S. Kimura.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1573-1582, 1991. 8 fig, 7 tab, 1 ref.

Descriptors: *Biofilm reactors, *Biological wastewater treatment, *Membrane filters, *Wastewater reactors, *Wastewater renovation, *Wastewater treatment, *Water reuse, Energy costs, Industrial wastewater, Membranes, Pretreatment of wastewater.

Aqua Renaissance 90 is a six year research and development project for water reuse and energy recovery supported by the Japanese Ministry of International Trade and Industry. The objective is to develop low cost treatment processes utilizing bioreactors coupled with membrane separation units to produce reusable water from industrial wastewater and sewage. Polymeric and ceramic membranes in capillary, hollow fiber, tubular, plate and frame modules have been tested in conjunction with bioreactors on a number of actual wastewater and sewage streams. An important problem associated with wastewater treatment is the pretreatment phase of the system. Excessive use of pretreatment leads to high-cost performance, while simple treatment leads to severe fouling of membranes and modules and poor equipment performance. In the Aqua Renaissance Project, membranes and modules are used without any pretreatment. The project studied the performance of various membranes and the power consumed by each process. Results from the test plant operations revealed that successful treatment of concentrated wastewater could be accomplished by the use of membrane separation units. In addition, the units used less than a third of the conventional power requirement. (Author's abstract)
W91-05766

EFFECT OF OPERATIONAL FACTORS ON SOLID/LIQUID SEPARATION BY ULTRA-MEMBRANE FILTRATION IN A BIOLOGICAL DENITRIFICATION SYSTEM FOR COLLECTED HUMAN EXCRETA TREATMENT PLANTS.
Institute of Public Health, Tokyo (Japan). Dept. of Sanitary Engineering.
Y. Magara, and M. Itoh.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1583-1590, 1991. 12 fig, 2 tab, 1 ref.

Descriptors: *Denitrification, *Domestic wastes, *Filtration, *Membrane filters, *Wastewater treatment, Biodegradation, Energy costs, Gels, Hydraulic loading, Japan, Separation techniques, Suspended solids, Temperature effects, Ultrafiltration, Wastewater facilities, Wastewater reactors.

One third of the total population of Japan is served by collected human excreta treatment systems for the sanitary treatment of human wastes. In order to cope with the stringent effluent quality regulations set for human excreta treatment plants, the high-load biological denitrification process with ultra-membrane filtration for solid/liquid separation has been recently developed. This system has advantages not only with respect to the solid/liquid separation stage of biological treatment processes, but also with regard to the cost and operational effectiveness of advanced treatment processes (e.g., ozonation and activated carbon adsorption). However, problems can be experienced with the ultra-membrane filtration process because the attainable hydraulic load is completely governed by the permeation flux. Therefore, in order to utilize the ultra-membrane filtration process in a biological wastewater treatment system, the effects of the operational factors on the permeation flux must be clarified. The effects of water temperature, suspended solids concentration, driving pressure, and water velocity on the treatment process were studied. Results revealed that in order to attain a stable permeation flux, the water temperature and suspended solids concentration should be kept as stable as possible. In addition, the development of cake or gel layer resistance showed that high pressure and high velocity gave a high and stable permeation flux. However, it has also been shown that the optimum operational conditions are high pressure and low velocity, due to the energy costs for operation of the system. (Author's abstract)
W91-05767

MEMBRANE BIOREACTOR ON DOMESTIC WASTEWATER TREATMENT SLUDGE PRODUCTION AND MODELLING APPROACH.
Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
S. Chaize, and A. Huyard.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1591-1600, 1991. 10 fig, 4 tab, 16 ref.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Domestic wastes, *Membrane filters, *Model studies, *Wastewater treatment, Biodegradation, Biomass, Kinetics, Maintenance, Membranes, Microbiological studies, Pilot plants, Retention time, Sludge, Ultrafiltration, Wastewater reactors.

Conventional biological processes for wastewater treatment use biomass recycling to increase the microorganism concentration in the aeration tank. Membrane separation techniques have been used for biomass recycling in wastewater treatment processes. The effects of solids retention time (SRT) and hydraulic retention time (HRT) on the performance of a completely mixed biological reactor connected to an ultrafiltration module were studied in a pilot plant run under variable operating conditions (i.e., SRT and HRT). The results revealed that changes in the operational parameters of the reactor had no effect on the water quality produced. Data obtained in the experiments were then compared to theoretical values calculated using biological wastewater treatment models. Major disagreements were noted in biomass concentrations between modelling and experimental results with experimental values being generally lower than theoretically predicted values. These differences may be due to the large SRT and low HRT used in the experiments. In addition, the maintenance phenomena, which express the energy consumption necessary for the endogenous respiration of the microorganisms, was not incorporated into the model. In order to better understand the biological reactions involved in this process, it is necessary to further develop the maintenance concept and its application to conventional wastewater treatment prediction models. (Korn-PTT)
W91-05768

EFFECTS OF ACTIVATED SLUDGE PROPERTIES ON WATER FLUX OF ULTRAFILTRATION MEMBRANE USED FOR HUMAN EXCREMENT TREATMENT.
Kurita Water Industries Ltd., Tokyo (Japan). Technical Dept.
T. Sato, and Y. Ishii.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1601-1608, 1991. 3 fig, 4 tab, 3 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Domestic wastes, *Ultrafiltration, *Wastewater treatment, Chemical oxygen demand, Correlation analysis, Filtration, Japan, Membranes, Viscosity.

In the treatment of human excrement in Japan it is becoming increasingly necessary to develop compact, water-saving treatment systems due to the shortage of dilution water and construction sites. However, for non-dilution, high-load treatment processes, it is necessary to raise the activated sludge concentration (MLSS) in a biological reactor and develop high quality solid-liquid separation techniques. Attention has been focused on the utilization of ultrafiltration (UF) membranes for solid-liquid separation. A study investigated the relationship between water flux of a UF membrane to MLSS, sludge viscosity, and soluble chemical oxygen demand (COD) with a high-concentration activated sludge suspension fed through the UF membrane. A bench scale plate and frame UF membrane test unit was used for the experiments. All runs reached a stable state water flux after 20-50 hours of operation. Correlation analysis was then performed on the data and an estimate of +/- 24% was obtained for the filtration resistance in the test unit. It was determined that soluble COD had the largest effect on water flux, followed by MLSS, while the effect of viscosity was relatively small. (Korn-PTT)
W91-05769

DISINFECTION AND CLARIFICATION OF TREATED SEWAGE BY ADVANCED MICROFILTRATION.
Memtec Ltd., Windsor (Australia).
M. Kolega, G. S. Grohmann, R. F. Chiew, and A. W. Day.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1609-1618, 1991. 5 tab, 21 ref.

Descriptors: *Advanced wastewater treatment, *Clarification, *Disinfection, *Filtration, *Membrane filters, *Microfiltration, *Secondary wastewater treatment, *Wastewater treatment, Bacteria, Biofouling, Biological oxygen demand,

Grease, Heavy metals, Membranes, Microbiological studies, Phosphorus, Suspended solids, Turbidity, Viruses.

A study was conducted to investigate the use of an advanced membrane microfiltration system to disinfect and clarify secondary and primary treated sewage. The membrane microfiltration system tested incorporated a patented gas backwashing technique which significantly reduces fouling. A comprehensive microbiological testing program established that all indicator bacteria and viruses were removed by this system. Testing for chemical quality showed significant reductions in biological oxygen demand (BOD), suspended solids, turbidity, phosphorus, oil/grease, and heavy metals. Consistent filtration rates over several months were achieved without significant biological fouling. The study conclusively showed the capability of the microfiltration system to disinfect and clarify treated sewage. (Author's abstract)
W91-05770

EFFLUENT POLLUTION CONTROL OF OSAKA NORTH PORT DREDGED SOIL DISPOSAL SITE (NORTH SECTION-SITE II AND III).
Osaka City Inst. of Public Health and Environmental Sciences (Japan). Dept. of Environmental Technology.
I. Fukunaga, K. Takamizawa, Z. Inoue, T. Hasebe, and M. Konae.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1619-1628, 1991. 10 fig, 2 tab, 11 ref.

Descriptors: *Filtration, *Membranes, *Stabilization ponds, *Wastewater treatment, *Water pollution control, *Water pollution prevention, Chemical oxygen demand, Dredging wastes, Effluents, Eutrophication, Japan, Microorganisms, Osaka, Phytoplankton, Solid waste disposal, Suspended solids.

In Osaka City, the dredged soil has been disposed in a sea-based solid waste disposal site since 1975. The pond at the solid waste disposal site allows sedimentation and purification of a very large bulk of wastewater associated with the dumped dredged soil. According to monthly monitoring of the pond, chemical oxygen demand (COD) values rose in the spring and autumn along with suspended solids concentration to a value of 50.6 mg/l. It was determined that the rise in COD values was the result of exponential growth of phytoplankton in the pond and appropriate wastewater treatment measures were necessary. A pollution prevention membrane of 30 m width and 2 m depth was constructed to remove the phytoplankton from the effluent. The maximum effective level of COD removal achieved by the pollution prevention membrane was 73% and COD values in the pond were kept below 20 mg/l. From the point of both construction and maintenance costs, it was concluded that the pollution prevention membrane was the most economical method for wastewater treatment. (Author's abstract)
W91-05771

TECHNOLOGICAL DEVELOPMENT OF A WASTEWATER RECLAMATION PROCESS FOR RECREATIONAL REUSE: AN APPROACH TO ADVANCED WASTEWATER TREATMENT FEATURING REVERSE OSMOSIS MEMBRANE.
Tokyo Sewerage Bureau (Japan). Engineering Research and Development Section.
Y. Suzuki, and T. Minami.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1629-1638, 1991. 6 fig, 2 tab.

Descriptors: *Advanced wastewater treatment, *Membranes, *Reclaimed water, *Wastewater renovation, *Wastewater treatment, *Water reuse, Chemical oxygen demand, Fecal coliforms, Fouling, Membrane filters, Phosphorus, Recreation, Reverse osmosis, Water quality, Water use.

The Tokyo Metropolitan Government has been exploring ways of reclaiming wastewater to produce high-quality low-cost water for recreational reuse by using a reverse osmosis membrane in advanced wastewater treatment. The parameters used to evaluate the membrane were the permeate quantity, permeate water quality, flux decline coefficient, and recovery rate of the permeate quantity by chemical cleaning. As a result of the study, spiral-wound polyvinyl alcohol composite membranes and hollow-fiber cellulose triacetate reverse osmosis membranes were found to be of high practical value. The permeate through these membranes was colorless, transparent, and odorless, with an appearance equivalent to city water. The rejection rate of the fecal coliform group was 100% and the chemical oxygen demand (COD) of the permeate was 1-2 mg/l, with a chromaticity of 1 degree or less and a phosphorus content of 0.01 mg/l. Under the same pressure condition, these membranes provided three times more permeate quantity than a conventional acetyl cellulose membrane having a time-proven performance. Moreover, these membranes were sufficiently resistant to fouling and could recover to a 100% permeate quantity by chemical cleaning once they were fouled. (Author's abstract)
W91-05772

TANNERY WASTEWATER TREATMENT USING A SEQUENCING BATCH MEMBRANE REACTOR.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
K. Yamamoto, and K. M. Win.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1639-1648, 1991. 8 fig, 2 tab, 13 ref.

Descriptors: *Industrial wastewater, *Membrane filters, *Membranes, *Microfiltration, *Tannery wastes, *Wastewater reactors, *Wastewater treatment, Ammonia, Chemical oxygen demand, Chromium, Filtration, Heavy metals, Nitrogen removal, Organic loading, Retention time, Separation techniques.

The feasibility of a laboratory-scale sequencing batch membrane reactor (SBMR) was investigated for the treatment of wastewater from a tannery operation in Bangkok, Thailand. Tannery wastewater is considered toxic as it contains high strength organic matter and chromium. The SBMR system consisted of a hollow fiber microfiltration unit in a sequencing batch reactor (SBR) for solid-liquid separation. The aim of the design was to enhance sludge concentration in the reactor thereby promoting the stable removal of organic matter and heavy metals. The results of the investigation revealed that the removal efficiency for chemical oxygen demand (COD) was 93.7 to 96.3% while total chromium had a removal efficiency of 95.4 to 97.7%. In order to attain stable filtration, the critical sludge concentration was determined to lie between 30,000 and 40,000 mg/l. Lower solid retention times (SRT) gave lower Cr content in the sludge under conditions of constant organic loading. Higher organic loading generally resulted in lower Cr values at fixed SRT, except in the case of the longest SRT. An SRT of 20 days gave the highest ammoniacal/total nitrogen removal values while a shorter SRT of 10 days had adverse effects on the nitrifying bacteria because of their low growth rate. Judging from the process stability in terms of the removal of organic matter, nitrogen, chromium, and the flux, an SRT of 20 days was selected as the most appropriate. However, with an SRT of 20 days, it was recommended that volumetric organic loading be kept less than 8 kgCOD/cu m/d. (Author's abstract)
W91-05773

APPLICATION OF FIBER ADSORBENTS IN WATER TREATMENT.
Tokyo Univ. (Japan). Inst. of Industrial Science.
M. Suzuki.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1649-1658, 1991. 10 fig, 7 ref.

Descriptors: *Activated carbon, *Adsorbents, *Adsorption, *Fibrous beds, *Wastewater treatment, *Water treatment, Activated carbon fiber, Diffusion, Dispersion coefficient, Groundwater pollution, Mass transfer, Phosphorus removal, Trichloroethylene, Water pollution treatment, Zirconium oxide.

One of the problems met in application of adsorption processes in water treatment is the slow kinetics of adsorption which is due to the slow intraparticle diffusion in granular adsorbents such as granular activated carbon (GAC) in liquid phase. However, in the recently developed activated carbon fibers (ACF), the controlling step of adsorption kinetics becomes axial dispersion in the packed beds of fibers. By using the correlation of axial dispersion in fiber beds, breakthrough curves from fiber beds can be estimated. Because of its small diffusion distance in the fiber, fibrous adsorbents provide much faster adsorption kinetics compared with granular adsorbents. The application of fiber adsorbents may lead to smaller adsorption reactors and effective recovery of valuable components present in wastewater. Adsorption of trichloroethylene from contaminated groundwater on activated carbon fiber and the removal of phosphate from wastewater by adsorption on zirconium oxide particles supported on cotton cellulose fibers have been successful. For the purpose of establishing the application of fiber adsorbents, there are still several problems left for research, including the establishment of regeneration methods of spent adsorbents and the production of fiber adsorbents with less cost. (Korn-PTT)
W91-05774

POLLUTANT ADSORPTION ONTO ACTIVATED CARBON MEMBRANES.
Ecole Nationale Superieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Genie de l'Environnement.
M. Baudu, P. Le Cloirec, and G. Martin.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1659-1666, 1991. 7 fig, 3 tab, 10 ref.

Descriptors: *Activated carbon, *Adsorbents, *Adsorption, *Adsorption kinetics, *Membranes, *Wastewater treatment, *Water treatment, Aromatic compounds, Mass transfer, Model studies, Nitrophenols, Phenols, Velocity coefficient, Waste treatment, Water reuse.

The removal of pollutants from diluted aqueous solution is often performed with the use of activated carbon in the form of a membrane. A series of experiments were performed using batch reactors and pilot units to evaluate the performance of the activated carbon membranes on aqueous solutions containing aromatic compounds. The results indicated that very rapid adsorption was obtained as a result of using the activated carbon membranes. The membranes had maximum adsorption capacities that were slightly higher than that of activated carbon grains or powder. After testing the operating parameters and determining the breakthrough curves in the case of phenol adsorption, a simple model was obtained which could be used to derive the breakthrough curves. The velocity and inlet concentrations were parameters for the proposed model. The utilization of the membrane in the field of water purification or wastewater treatment seems to be promising. The material could be used as a final stage for water previously treated by classical processes or ultrafiltration membranes. Small treatment units could, therefore, be designed for producing drinking water, treating waste or recycling water. (Korn-PTT)
W91-05775

RECOVERY OF DIRECT DYE AND ACID DYE BY ADSORPTION ON CHITOSAN FIBER-EQUILIBRIA.
Osaka Prefectural Univ., Sakai (Japan). Dept. of Chemical Engineering.
H. Yoshida, S. Fukuda, A. Okamoto, and T. Kataoka.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1667-1676, 1991. 8 fig, 3 tab, 13 ref.

Descriptors: *Activated carbon, *Adsorbents, *Adsorption, *Chitosan, *Dye industry wastes, *Industrial wastewater, *Waste recovery, *Wastewater treatment, Adsorption kinetics, Chitin, Desorption, Dyes, Isotherms, Pigments, Temperature effects.

Dyestuffs and pigments, once thought to be inert, nontoxic materials, are now believed to be very harmful to aquatic life in the rivers to which they have been discharged. Recent attention has focused on the possible use of an adsorption process for the treatment of these dyestuff wastes. A potential advantage of this process may be the ability to recover the dyestuffs in concentrated form. A study was conducted on the effectiveness of chitosan fibers on the adsorption of Brilliant Yellow (direct dye), Acid Orange II (acid dye), and Crystal Violet (basic dye). The results were compared to results obtained when activated carbon fibers were used for the same dyestuffs. The amount of adsorption of Brilliant Yellow and Acid Orange II on chitosan fibers was much larger than on the activated carbon fiber. However, Crystal Violet was adsorbed on the chitosan fiber to a small degree while the activated carbon fibers appeared to adsorb Crystal Violet very well. Experimental equilibrium isotherms for the adsorption of the dyes were measured using the batch method. The equilibrium isotherms appeared to be significantly affected by the initial concentration of the dye and temperature while the presence of NaCl seemed to have little effect. Irreversible desorption of the direct dye and the acid dye could be accomplished using dilute aqueous solutions of caustic soda, such as 20 mol/cu m. (Korn-PTT)
W91-05776

STEADY STATE PERFORMANCE OF ACTIVATED CARBON CONTACTORS.
Illinois Univ. at Urbana-Champaign. Dept. of Environmental Engineering.
U. K. Traegner, and M. T. Suidan.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1677-1686, 1991. 10 fig, 3 tab, 5 ref.

Descriptors: *Activated carbon, *Adsorbents, *Adsorption kinetics, *Mathematical models, *Model studies, *Wastewater treatment, *Water treatment, Adsorption, Diffusion, Mass transfer, Particle size, Sludge, Sludge analysis.

Granular and powdered activated carbon (GAC, PAC) processes are widely used to control pollutant levels in the water and wastewater treatment fields. One way that adsorption onto activated carbon can be accomplished is by using a completely mixed activated carbon contactor. In this process, operated at steady state, a continuous mass stream of the adsorbent is applied to the reactor. A mathematical model was derived for the steady state adsorption of pollutants from completely mixed activated carbon contactors. A sludge age distribution has been incorporated for the adsorbent in order to describe these processes accurately. The resulting mathematical model was solvable analytically using the homogeneous surface diffusion model (HSDM) as a descriptor of intraparticle mass transfer resistance. It was demonstrated that a single, equivalent particle size could be used for practical computations to approximate a particle size distribution encountered for commercially available carbons. Extension of the newly derived model for multicomponent competitive adsorption appears to be straightforward. In addition, an equivalent single component system could be used to study the behavior of a trace component in a multi-solute environment. (Korn-PTT)
W91-05777

MAGNESIUM INDUCED ALGAL FLOCCULATION IN A FLUIDIZED BED.
Montpellier-2 Univ. (France). Inst. des Sciences de l'Ingenieur.
S. Elmaleh, J. Coma, A. Grasmick, and L. Bourgade.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1695-1702, 1991. 7 fig, 3 tab, 8 ref.

Descriptors: *Algae harvesting, *Coagulation, *Flocculation, *Magnesium, *Oxidation ponds, *Wastewater treatment, Chemical precipitation, Fluidized beds, Hydrogen ion concentration, Sedimentation, Separation techniques, Sludge thickening, Suspended solids.

Upgrading of oxidation pond effluents by algal removal has received considerable attention in recent years considering the potential economic value of microalgae and the probable development of high-rate ponds where solids production is maximized. The effectiveness of the use of seawater and of magnesium in the removal of microalgae from oxidation pond effluents was investigated using a magnesium induced fluidized bed flocculation system. The results indicated that the major flocculating reaction was the magnesium hydroxide precipitation which occurred at pH 11.5. The next step was to intensify the liquid-solids separation by use of a fluidized bed flocculator packed with 800 micrometer inert resin particles provided with an inclined multitubular settler. The outcome of this step indicated that the total suspended solids abatement could reach 95% with a superficial upflow velocity of 35 m/h corresponding to a residence time through the whole unit of only 5 minutes. The energy requirement quantified by the pressure drop through the bed was very low and the waste sludge extracted from the settler was easily thickened. (Korn-PTT)
W91-05779

SEWAGE CLARIFICATION WITH MAGNETITE PARTICLES.
Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Div. of Chemicals and Polymers.
N. A. Booker, D. Keir, A. J. Priestley, C. B. Ritchie, and D. L. Sudarmana.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1703-1702, 1991. 3 fig, 8 tab, 8 ref.

Descriptors: *Adsorption, *Chemical coagulation, *Clarification, *Magnetite, *Wastewater treatment, Anaerobic digestion, Biological oxygen demand, Chemical oxygen demand, Coagulation, Costs, Flocculation, Iron oxides, Pilot plants, Process control, Wastewater facilities.

A new approach to sewage treatment involving the rapid clarification of raw sewage with fine magnetite particles has been investigated for a continuous pilot plant operating in Melbourne, Australia. In the clarification process, fine magnetite particles are mixed with partially settled raw sewage. During the mixing period, extra chemical coagulants are added which act synergistically with the magnetite in clarifying the raw sewage to a biological oxygen demand (BOD) level of approximately 40 mg/l BOD. The magnetite particles are then recovered by magnetic flocculation and settling. These particles are then passed to a magnetite washing stage where they are treated with a dilute caustic soda solution which strips the sewage organics from the particle surfaces to form a liquid sewage concentrate. The concentrate then undergoes anaerobic digestion to reduce the chemical oxygen demand (COD) by 80%. The washed magnetite particles are recycled for use in the clarification step. The technique can be applied to large flow rates and, as long as chemical costs are contained, offers hope for a significant reduction in total treatment costs. (Korn-PTT)
W91-05780

CHARACTERISTICS OF METAL-POLYSILICATE COAGULANTS.
Suido Kiko Kaisha Ltd., Tokyo (Japan). Div. of Research and Development.
For primary bibliographic entry see Field 5F.
W91-05781

OPTIMAL DESIGN FOR STORM SEWER SYSTEM WITH PUMPING STATIONS.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
J.-T. Kuo, B. C. Yen, and G.-P. Hwang.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 11-27, 1991. 5 fig, 5 tab, 11 ref.

Descriptors: *Cost analysis, *Design standards, *Hydraulic engineering, *Network design, *Sewer systems, Construction costs, Operating costs, Optimization, Pumping head, Pumping plants, Storm sewers, Taiwan.

A study was performed to develop a working model for the least-cost optimal design of a storm sewer system, including the construction and operational costs of pumping stations. The new model is a modification of the Illinois Least-Cost Storm-Sewer System Design Model (ILSD-1) developed at the University of Illinois. It can be applied to a storm sewer network, especially in a lowland area, with pumping stations inside or at the outlet of the network. In order to match the discrete differential dynamic programming optimization scheme used in ILSD-1, a pumping station is considered as an inserted stage. The state variables of the stage of a pumping station include not only the storm sewer crown elevations originally used in ILSD-1 but also the capacity of the pumping stations. The decision variable is the pumping head at the pumping stations. The cost of a pumping station is composed of the cost of pumps and the cost of detention storage. Hence, the optimal design of a pumping station is a trade-off between determining the size of the detention storage and the capacity of pumps. This new model has been satisfactorily applied to a storm sewer system with pumping stations in a lowland area in northern Taiwan. (Author's abstract)
W91-05787

SELECTION OF EGG-SHAPED SLUDGE DIGESTERS FOR BOSTON.
Massachusetts Water Resources Authority, Boston.
M. Thomas.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 8-9, January 1991. 2 fig.

Descriptors: *Massachusetts, *Sludge digestion, *Wastewater facilities, *Wastewater treatment, Boston, Design criteria, Primary wastewater treatment, Secondary wastewater treatment.

When construction is completed, the new Massachusetts Water Resources Authority (MWRA) wastewater treatment facilities on Deer Island, in Boston Harbor, will include a new 480-mgd primary and secondary wastewater treatment plant. The plant will have one of the largest installations of egg-shaped digesters in the world--both in number and in the size of the units. In 1989, MWRA had completed planning for residuals management facilities needed to end the illegal discharge of sludge into the harbor, by identifying several important issues: severely limited land area for all treatment needs; a high grit load to the plant; a history of digester problems including grit accumulation and scum blanket formation; a need for as much operator experience and input as possible into digester selection and design; sole financial support from rate-payers requiring close control on all economic aspects; and high visibility from surrounding areas. Review of several reactor configurations, including conventional U.S., deep conventional, and egg-shaped, caused the MWRA to conclude that egg-shaped digesters offered clear advantages for future operation and maintenance that offset their higher initial cost. The egg-shaped geometry enhances mixing and requires less energy to keep the contents well-mixed, mitigating grit accumulation problems. The advanced internal design of the egg-shaped digesters precludes separate digester cleaning facilities. Computer-aided design plots demonstrated that the already-planned manmade hill on the island would be large enough to screen the adjacent community from the plant. The initial eight digesters will be brought on line in 1994 to process primary sludge; the remaining four units will be needed by late 1999 when full secondary treatment is needed. (Fish-PTT)
W91-05801

COMPATIBILITY OF STREAM HABITAT RECLAMATION WITH POINT SOURCE AND NONPOINT SOURCE CONTROLS.
Colorado Univ. at Boulder.
For primary bibliographic entry see Field 5G.
W91-05802

GREATER CAIRO WASTEWATER PROJECT.
AMBRIC, Cairo (Egypt).
W. J. Buchholz, and J. P. Somerville.
Water Environment & Technology WAETEJ,

Vol. 3, No. 1, p 33-35, January 1991. 2 fig, 1 tab.

Descriptors: *Egypt, *Metropolitan water management, *Wastewater facilities, *Wastewater management, Groundwater movement, International commissions, Long-term planning, Secondary wastewater treatment, Sewer systems, Short-term planning, Soil moisture, Wastewater pollution.

The high population growth rate in Cairo, Egypt, caused overloading of the wastewater systems in the 1960s. In the late 1970s, planning began on a massive system sufficient to collect and treat the city's wastewater until the year 2010, when the population was estimated to reach 16 million. This effort is known today as the Greater Cairo Wastewater Project and the first phase is expected to be completed in 1994, with a total cost estimated at almost $2.5 billion. The planning has followed the general strategy of: (1) buy time and get wastewater out of the streets by rehabilitating the existing system; (2) devise methods to collect wastewater from the large number of unsewered areas; (3) design and build a new collection and transport system and connect it to the existing system; (4) build secondary treatment plants; (5) train local staff to administer, operate, and maintain the system; and (6) expand the collection system into the unsewered areas in conjunction with the water system expansion. The project is made possible by an international cooperative effort that includes governments, consulting engineers, and contractors. Another problem in the area is a result of the groundwater levels in the Sphinx/Pyramids area being higher than normal and, along with surface disposal of wastewater, contributing to the damage to the Sphinx in 1988 as a result of upward migration of soil moisture. The Sphinx Emergency Program was organized to provide local sewer service and to monitor groundwater movements and quality. Currently, a massive training program for operations staff is being organized, and the master plan is being reexamined and updated. (Fish-PTT)
W91-05804

STORMWATER MANAGEMENT UTILITY BILLING RATE STRUCTURE.

CH2M Hill, Inc., Gainesville, FL.
For primary bibliographic entry see Field 6C.
W91-05805

OPERATIONAL QUALITY IN WASTEWATER MANAGEMENT.

Water Pollution Control Federation, Alexandria, VA.
W. A. Peterson.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 50-52, January 1991. 1 fig.

Descriptors: *Wastewater facilities, *Wastewater management, *Wastewater treatment, Management planning, Operating policies, Personnel management, Process control, Quality control, Resources management, Water quality management.

Achieving operational excellence in the field of wastewater treatment means knowing the objective elements of quality and the 'Zen' or art of treatment plant operations. Quality operations have measurable characteristics and spiritual characteristics such as creativity, pro-activeness, service to the administration and community, truth and credibility in communications, and care and concern. The aspects of well-operated plants that are more easily measured or defined can be classified in three areas: output, process, and resource use. Output is the volume of wastewater treated and degree of treatment achieved. Well-designed and well-operated facilities meet or exceed design and permit standards for treatment efficiency, as measured by better-than-acceptable effluent quality. Process is at the heart of quality standards, and consists of the texture, feel, and color of operations; the process of operation is the way that results are achieved, the atmosphere in which the staff works, the environment created around the plant site, and all of the management systems that assure staff and facilities are maintained and developed. Quality operations have an aura of positiveness and a dedication to detail and concern, with high operator certification levels, ongoing operator training, high skill levels, safety priorities, responsive management, effective maintenance programs, and good community relations. A well-operated plant optimizes resource use by minimizing consumable costs for chemicals, labor, and consumable materials, while investing appropriate amounts of additional resources to assure consistent short-term performance, adequate care of capital investment, and capital reinvestments needed to improve and maintain asset value. Excellence in operations should be the goal of every wastewater treatment facility. (Fish-PTT)
W91-05806

EFFECTS OF AEROBIC THERMOPHILIC PRETREATMENT.

UTB, Buchs (Switzerland).
U. Baier, and H. P. Zweifelhofer.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 56-61, January 1991. 5 fig, 4 tab.

Descriptors: *Sludge digestion, *Sludge treatment, *Sludge utilization, *Wastewater management, *Wastewater treatment, Activated sludge, Europe, Sludge drying.

Most treatment facilities in Europe are now implementing optimization plans for sludge treatment. Primary objectives are to assure constant quality of stabilized sludges with respect to further treatment; the destruction of potentially pathogenic organisms with respect to agricultural use of sludges; the improvement of thickening properties of stabilized sludge with respect to storage volume, tanker costs, and mechanical dewatering; and the improvement of dewatering characteristics of thickened sludge with respect to drying, incineration, and disposal. Because of the rising demands for sludge quality, many mesophilic digesters can no longer meet treatment standards required for sludge used in agricultural land application. Aerobic thermophilic (AT) pretreatment followed by anaerobic digestion--dual digestion--has been applied in most cases in Europe. The dual sludge treatment process is a combination of pre-thickening of primary and waste activated sludge (either combined or separately), AT pretreatment, anaerobic mesophilic digestion, and storage and consolidation. Performance data from more than 70 plants shows that this process is an effective means to eliminate and control pathogenic organisms. The chosen combination of a temperature of >60 C and hydraulic retention time of 20 to 24 hours guarantees an operation free of short circuiting. Hydrolysis of organic material in the thermophilic reactor varies from 5% to 10% (volatile solids) and can easily be controlled by variation of oxygen input. Biogas production is not affected negatively by AT pretreatment. (Fish-PTT)
W91-05807

CLARIFICATION AND FILTRATION TO MEET LOW TURBIDITY RECLAIMED WATER STANDARDS.

Kennedy/Jenks/Chilton, Inc., San Francisco, CA.
J. A. Faller, and R. A. Ryder.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 68-73, January 1991. 3 fig, 4 tab.

Descriptors: *California, *Clarification, *Filtration, *Reclaimed water, *Wastewater renovation, *Wastewater treatment, *Water reuse, Clarified wastewater, Flocculation, Pilot plants, Trickling filters, Turbidity, Wastewater facilities, Water quality standards.

The use of treated wastewater for field and crop irrigation has become prevalent in the state of California in the last 25 years. California water and wastewater management districts have been challenged to incorporate reclaimed water into existing treatment and conveyance systems while meeting tightening state water quality standards. Wastewater treatment plants (WWTPs) using trickling filters in their secondary treatment train have a unique problem: trickling filter effluent does not meet California's turbidity standard (less than 2 nephelometric turbidity units (NTUs)). At a reclamation plant operated by the Marin Municipal Water District (MMWD), an in-depth evaluation of clarification and filtration options was undertaken to identify the most economical and effective process to treat trickling-filter effluent to meet turbidity standards for reclaimed water. Bench-scale tests indicated that conventional flocculation and clarification were the best processes; however, high concentrations of alum were required to produce good settling. Three pilot processes were tested: high-rate solids-contact and upflow clarification processes for treatment upstream of the existing direct filtration reclamation plant, and a diatomaceous-earth filtration (DEF) process for polishing treatment downstream of the existing sand filters. It was found that all three of the pilot plants tested were successful in removing turbidity in the wastewater to less than 2 NTU. Alternative plant improvement facilities were compared on the basis of capital costs, operation and maintenance costs, annual cost effectiveness, and non-monetary factors. Proportionate ranking of these factors favored the high-rate solids-contact clarification process as the best project to design and construct. (Fish-PTT)
W91-05808

POTABLE WATER REUSE.

CH2M/Hill, Denver, CO.
C. L. Hamann, and B. McEwen.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 74-80, January 1991. 1 fig.

Descriptors: *Potable water, *Water quality management, *Water resources management, *Water reuse, *Water supply development, *Water treatment, Wastewater management, Water quality standards, Water treatment facilities.

Water reuse is becoming an increasingly common component of water resource planning as opportunities for conventional water-supply development dwindle and costs for wastewater disposal climb. For indirect, potable reuse, the recovered water must be of equal or better quality than the receiving water source. For direct, potable reuse, the receiving water must be of equal or better quality than the finished water produced from the highest quality source water locally available. Close involvement with state and local agencies is paramount to the development of a potable reuse implementation program that encourages a variance from regulation prohibition, serves as a catalyst for the development of potable reuse regulations, and persuades responsible agencies of the benefits and safety of the project. Unit processes often included in a reuse facility are biological treatment with or without nitrogen removal, high-lime treatment with two-stage recarbonation, granular-media filtration, granular activated carbon (GAC), demineralization (membrane treatment), air stripping, rapid infiltration and recovery, and disinfection. Selection of a potable reuse treatment and its planned integration into a water-supply system is site-specific; the conceptual layout and specific treatment selected should satisfactorily address health, regulatory, social, and technical issues and concerns. The economic feasibility of potable reuse should be based on a cost comparison of developing other raw water supplies. The steps necessary to implement a potable reuse project address the issues and concerns regarding water quality standards and public health; legal, regulatory, and political influences; public acceptance; and technical process engineering. (Fish-PTT)
W91-05809

MAJOR UNIT PROCESS EVALUATION USING THE COMPOSITE CORRECTION PROGRAM APPROACH.

GPU Nuclear Corp., Middletown, PA.
S. R. Cogley.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 1, p 18-21, January/February 1990. 2 fig, 3 tab, 2 ref.

Descriptors: *Public utility districts, *Wastewater facilities, *Wastewater management, *Wastewater treatment, Administration, Design standards, Economic efficiency, Maintenance, Operation, Performance evaluation, Water quality control.

Improved Publicly Owned Treatment Works (POTW) performance can be accomplished by an evaluation phase, known as Comprehensive Performance Evaluation (CPE), and by a performance improvement phase, known as a Composite Correction Program (CCP). A CPE consists of a review and analysis of the POTW design and of other non-design areas such as administration, operation, and maintenance. If the CPE results indicate that significant improvements can be achieved without a major upgrade, then a CCP is implemented to improve POTW performance. The primary CPE activity is the evaluation of POTW major unit processes using current plant loadings, categorizing the adequacy of the current unit process design by categorizing the POTW as Type 1, 2, or 3 (from most to least adequate) using a point system evaluation. Suspended growth major unit process evaluations were conducted at three POTWs to determine the relative effectiveness of the CPE procedure. It was found that CPE unit process evaluation appeared to be appropriate, and results can provide the experienced evaluator with useful preliminary assessment information on POTW major unit process capacities. The CPE evaluation process is not intended to and cannot replace the judgment and knowledge of the experienced professional who can effectively factor unit process evaluation results into an overall assessment of existing process capabilities. In combination with other evaluator skills, properly interpreted and derived CPE unit process capacity results will provide a sound basis for determining whether a major facility upgrade is required to achieve improved POTW effluent quality. (Fish-PTT)
W91-05811

MODIFYING EXISTING ACTIVATED SLUDGE PLANTS TO ACHIEVE NITRIFICATION AND DENITRIFICATION.
Stearns and Wheeler, Cazenovia, NY.
D. E. Schwinn.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 1, p 23-29, January/February 1990. 8 fig, 1 tab, 4 ref.

Descriptors: *Activated sludge process, *Nitrogen removal, *Wastewater facilities, *Wastewater management, *Wastewater treatment, Aeration, Denitrification, Massachusetts, New York, Nitrification, Water quality standards.

In some areas of the U.S., water quality criteria require the removal of nitrogen from wastewater treatment plant effluents. Modification of an activated sludge process to a single-stage nitrification-denitrification reactor using intermittent aeration is a viable option when nitrogen removal is desired. To allow implementation of the single stage nitrification-denitrification process at an existing facility, necessary process operation and control features include: (1) sufficient tank volume and aeration capacity to allow complete nitrification; (2) timers on the aeration equipment to provide aerobic-anoxic cycling; (3) monitoring of nitrification by alkalinity measurements using an ammonia probe (chemical addition may be necessary); (4) monitoring of denitrification by nitrate analysis; (5) proper solids inventory and attention to solids wasting to maintain the required solids retention time; and (6) operator understanding of the fundamentals of each major process involved and the basic process interrelationships. The methodologies were used to convert three existing plants (Oswego, NY; Clinton, NY: and Barnstable, MA) to incorporate nitrogen removal. (Fish-PTT)
W91-05812

BIOLOGICAL TREATMENT FOR HAZARDOUS WASTES.
C. G. Golueke, and L. F. Diaz.
Biocycle BCYCDK, Vol. 30, No. 12, p 58-63, December 1989. 12 ref.

Descriptors: *Biodegradation, *Biological treatment, *Hazardous waste treatment, *Hazardous wastes, *Waste management, *Waste treatment, *Wastewater treatment, Activated sludge process, Aerated lagoons, Anaerobic digestion, Biological wastewater treatment, Composting, Contactors, In situ treatment, Land disposal, Microbial degradation, Microorganisms, Solid wastes, Trickling filters.

Biological treatment of hazardous wastes is the use of microbes (microorganisms) to break down harmful compounds found in wastes to innocuous intermediate or end products. A major advantage of biological systems over most thermal and chemical systems is their ability to break down toxic substances in situ at lower cost and less time. If active microbes are not indigenous in the waste, either naturally occurring or genetically engineered microbes are introduced by inoculation, mass inoculation, recirculation, or other means. Nitrogen (N) is usually the limiting nutrient in hazardous wastes, and must be added in a form and concentration available to active microbes to promote a growth rate equal to or greater than that of competitive microbes. The system should be maintained at the optimum temperature (i.e., that of the active microbes). The type of treatment selected is, in part, a function of the physical state of the waste (liquid, solid, or intermediate). Among the systems available for the biological treatment of wastes in liquid form are the activated sludge system, aerated lagoon, trickling filter, and rotating biological contactor (rotating disk). Composting and land treatment ('land-farming') are the two most commonly used methods for the biological treatment of solid hazardous wastes. Anaerobic digestion ranks a distant second (or third). (Fish-PTT)
W91-05843

START-UP REGIMES FOR ANAEROBIC FLUIDIZED SYSTEMS TREATING DAIRY WASTEWATER.
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
D. M. L. da Motta-Marques, S. M. Cayless, and J. N. Lester.
Biological Wastes BIWAED, Vol. 34, No. 3, p 191-202, 1990. 6 fig, 1 tab, 26 ref. Science and Engineering Research Council Grant GR/E/28734.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Dairy industry, *Fluidized bed process, *Organic wastes, *Wastewater treatment, Animal wastes, Biofilm reactors, Chemical oxygen demand, Fatty acids, Fluidized beds, Industrial wastes, Volatile acids.

High-rate anaerobic systems such as fluidized beds are known to be suitable for the treatment of industrial effluents of large volume and high organic strength. However, the problem of effective start-up must be addressed when treating organic wastes. Biofilm accumulation and reactor performance are influenced by separation of the anaerobic process into two phases, the addition of metal ions, and the addition of biological polymer extracted from anaerobically-digested sludge. Four anaerobic fluidized beds were started up on a dairy-type effluent of 5000 mg chemical oxygen demand (COD)/L using different regimes: (a) two-phase; (b) Ca(+2) addition; (c) polymer addition; and (d) control. Substrate removal efficiencies reached 76-92% at 9.4 kg COD/cu-m/day in the two-phase, calcium-amended and biopolymer-amended reactors. The data suggest that removal efficiency and biomass concentration peaks were variable but mature biofilms, which were dependent on the protocol applied, were developed in these three reactors. Volatile fatty acids concentrations were reflected by intermediary/partial alkalinity variations. If the quick establishment of operational reactors is needed, calcium and biopolymer addition might be considered, although with low substrate-removal efficiencies compared to a two-phase system. The combination of phase separation with calcium or biopolymer would perhaps aid the formation of a biofilm with high removal efficiency and reduce the time required to establish this highly active biofilm. (Fish-PTT)
W91-05844

ANAEROBIC DIGESTION OF WASTES CONTAINING PYROLIGNITIC ACIDS.
Turin Univ. (Italy). Ist. di Microbiologia ed Industrie Agrarie.
V. Andreoni, P. Bonfanti, D. Daffonchio, C. Sorlini, and M. Villa.
Biological Wastes BIWAED, Vol. 34, No. 3, p 203-214, 1990. 4 fig, 3 tab, 21 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Industrial wastes, *Lignin, *Wastewater treatment, *Wood wastes, Biodegradation, Biological treatment, Hazardous wastes, Organic acids, Organic wastes, Phenols, Pyrolysis, Toxic wastes, Wastewater reactors.

Liquid effluents from pyrolysis of wood residues (pyrolignitic acids) are known to contain several compounds originating from the breakdown of lignin. The use of anaerobic treatment for highly-concentrated wastewaters is growing since the absence of oxygenation, the small amount of sludge generated, and the production of biogas are all advantages over conventional aerobic processes. Anaerobic digestion was applied to the treatment of a mixture of a solution of pyrolignitic acids and diluted swine slurry. The swine slurry was added to adjust the pH and to dilute the solutions containing pyrolignitic acids to a concentration of phenolic compounds not potentially inhibiting to anaerobic microorganisms. Small quantities of the mixture were digested in two anaerobic fixed-bed upflow digesters, filled with wood-chips or PVC as support media. The two digesters showed about the same efficiency when treating swine slurry containing pyrolignitic acids up to 6.5% (v/v). With a 10% (v/v) concentration, chemical oxygen demand removal efficiency, specific biogas production, and pH of the effluent, (utilized as process-efficiency parameters) decreased remarkably for both plants. However, the digester with wood-chips showed a stronger resistance to the presence of pyrolignitic acids. Therefore, a fixed-bed upflow digester with wood-chips can be considered a suitable plant to treat wastes with a high organic concentration and containing toxic substances. (Fish-PTT)
W91-05845

ANAEROBIC DIGESTION OF PESTICIDE-PLANT WASTEWATER.
Feng Chia Univ., Taichung (Taiwan). Dept. of Hydraulic Engineering.
C. Y. Lin.
Biological Wastes BIWAED, Vol. 34, No. 3, p 215-226, 1990. 7 fig, 3 tab, 11 ref. Taiwan National Science Council grant no. NSC7-0410-E305-03Z.

Descriptors: *Anaerobic digestion, *Biological treatment, *Organophosphorus pesticides, *Pesticides, *Wastewater management, *Wastewater treatment, Acetates, Biodegradation, Biological studies, Biological wastewater treatment, Chemical oxygen demand, Industrial wastewater, Pesticide residues, Taiwan, Toxic wastes.

Pesticide manufacturing industries are essential to the development of agriculture and economics in Taiwan. However, the need for better environmental quality requires industry to pay more attention to pollution problems, particularly toxic wastewater. Some pesticide industry wastewater contains a high percentage of acetate, which is known to be a major intermediate product of anaerobic digestion and also a major methane precursor. An experiment was performed to investigate the digestibility and operating parameters for the anaerobic digestion of pesticide-plant wastewater containing a high percentage (62%) of acetate, using chemostat-type digesters maintained at 35 C. The influent chemical oxygen demand (COD) concentration was 9650 mg/L. The digesters operated stably at the retention times of 15, 20, and 30 days, with COD removal efficiencies of 87.0, 89.4, and 91.5%, respectively. The biokinetic constants were: maximum specific substrate utilization rate 3.37 mg COD/mg/day; substrate saturation concentration 4077 mg COD/L; growth yield of microorganism 0.148 volatile suspended solids/mg COD; and endogenous decay coefficient of microorganism 0.050/day. Bacilli and sarcinae were the predominant morphological species and the dominance was independent of retention time. The optimal retention time was 15 days. It may be concluded that anaerobic digestion of this type of wastewater is feasible. (Fish-PTT)

W91-05846

WATER-QUALITY EFFECTIVENESS OF A DETENTION/WETLAND TREATMENT SYSTEM AND ITS EFFECT ON AN URBAN LAKE.
Metropolitan Council, St. Paul, MN.
G. L. Oberts, and R. A. Osgood.
Environmental Management EMNGDC, Vol. 15, No. 1, p 131-138, January/February 1991, 1 fig, 6 tab, 12 ref.

Descriptors: *Artificial wetlands, *Lake management, *Storm water management, *Surface detention, *Urban areas, *Water quality management, *Wetland treatment, Lake McCarrons, Lake restoration, Minnesota, Phosphorus, Rainfall-runoff relationships, Suspended solids.

A newly installed combined detention/wetland stormwater treatment facility upstream from Lake McCarrons, Roseville, Minnesota, was monitored for 21 months to evaluate its effectiveness and the response of the lake to decreased phosphorus loads. The treatment facility consists of a 1.0-ha detention pond that discharges into a series of six constructed wetland 'chambers'. Flow was continuously monitored from September 1986 through May 1988 and was automatically sampled during 21 rainfall and four snowmelt events at the outflow of the detention pond and at the wetland system outflow. Event samples were flow-composited and analyzed for total suspended solids, volatile suspended solids, chemical oxygen demand, total phosphorus, dissolved phosphorus, total Kjeldahl nitrogen, nitrate nitrogen, and total lead. Data collected for the wetland treatment system show that the best overall reductions are for pollutants associated with solids and with the particulate portion of the nutrient load. Soluble nutrients are not as easily removed because of their tendency to move quickly through the system. Data from the lake show very little change in its water quality from three years prior to restoration (1984-1986) to three years following restoration (1987-1989): the lake's phosphorus and chlorophyll has actually increased. (Author's abstract)
W91-05908

UTILIZATION OF ADIPIC ACID BYPRODUCTS FOR ENERGY RECOVERY AND ENHANCEMENT OF FLUE GAS DESULFURIZATION.
Monsanto Chemical Co., Pensacola, FL.
C. T. Chi, and J. H. Lester.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 223-226, November 1989, 6 fig, 1 tab, 12 ref.

Descriptors: *Chemical wastewater, *Desulfurization, *Emissions control, *Energy recovery, *Waste recovery, *Waste utilization, *Wastewater treatment, Additives, Energy use efficiency, Organic acids, Separation techniques, Sulfur dioxide.

Beneficial utilization of two waste streams from adipic acid manufacture has resulted in the creation of product for the enhancement of flue gas desulfurization in coal fired power plants and for energy recovery. The first stream was a waste liquor from the crystallization of adipic acid, containing adipic, glutaric, and succinic acids. This mixture (AGS) was found to be very effective in improving the efficiency of limestone scrubbers for removing SO2 from coal fired power plant gases. Most of this waste liquor is directed to an evaporator and concentrated to 50% organic solids for sales to coal-fired utilities. AGS enhances mass transfer of SO2 in limestone scrubbers by acting as a suitable buffer and increases removal efficiency by 50-90% enabling the user to meet regulatory requirements. The sale of AGS has resulted in a growing multimillion pound per year business. The second waste stream was a residue from cyclohexanol refining. The waste liquor contains 25% dibasic acids, water and sodium and boron contaminants. The inorganics are removed by liquid-liquid extraction in a contact centrifuge, while the oil phase plus excess AGS is incinerated in the plant boiler for fuel value recovery. (Doyle-PTT)
W91-05909

OIL RECOVERY AND WASTE REDUCTION BY MICROWAVE RADIATION.
University of Southwestern Louisiana, Lafayette. Dept. of Chemical Engineering.
C. S. Fang, P. M. C. Lai, B. K. L. Chang, and W. J. Kloila.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 235-238, November 1989, 4 fig, 2 tab, 7 ref.

Descriptors: *Microwaves, *Oil recovery, *Oil wastes, *Separation techniques, *Waste reduction, *Wastewater treatment, Emulsions, Industrial wastes, Oil-water interfaces, Recycling, Waste recovery.

Oil-in-water and oil-water-solid emulsions, byproducts of various industrial operations, often are environmental concerns. Laboratory and field tests have shown that these emulsions can be demulsified and separated into their individual layers by microwave radiation. The data also show that microwave separation is faster than gravity separation and can be faster than conventional heating under many conditions. After separation of emulsion water, slop and oil layers, water can be discharged and oil collected for recycle. The volume of slop is much smaller than the original volume of emulsion: therefore, the oily waste to be disposed of is greatly reduced. The zeta potential of oily droplets in water was measured and found that it is reduced by microwave radiation. This indicates that microwaves provide heating and reduction of zeta potential in demulsification. (Author's abstract)
W91-05910

EVALUATION OF MEMBRANE PROCESSES FOR THE REDUCTION OF TRACE ORGANIC CONTAMINANTS.
Tenera Corp., Berkeley, CA.
S. Lyandres, and J. Meardon.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 239-244, November 1989, 8 fig, 2 tab, 11 ref.

Descriptors: *Membrane processes, *Organic pollutants, *Pretreatment of wastewater, *Reverse osmosis, *Waste reduction, *Wastewater treatment, Cellulose acetate membranes, Comparison studies, Performance evaluation, Separation techniques, Total organic carbon, Trace levels.

Reverse osmosis (RO) was experimentally tested on liquid condensates produced from a pilot evaporative crystallizer. The condensates contained residual light organic compounds. The original sources of the condensate feeds were two solar evaporation ponds that received treated liquid effluents from a hazardous waste treatment and disposal facility. The condensates differed in type and concentrations of organics. Two brands of RO membranes were compared and both exhibited 98% plus removal efficiency for organics over a wide range of test conditions. Permeate qualities were consistently less than 50 mg/L of total organic carbons (TOC) with typical ranges from 10-30 mg/L. TOC were reduced to levels acceptable for discharge into local publicly-owned treatment works or surface waters. Thus, RO is a viable secondary treatment process for the removal of organic compounds from liquid waste streams. (Doyle-PTT)
W91-05911

EFFLUENT TREATMENT FOR ALCOHOL DISTILLERY: THERMAL PRETREATMENT WITH ENERGY RECOVERY.
Bombay Univ. (India). Dept. of Chemical Technology.
S. S. Lele, P. J. Rajadhyaksha, and J. B. Joshi.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 245-252, November 1989, 8 fig, 10 tab, 23 ref.

Descriptors: *Distillation, *Energy recovery, *Industrial wastes, *Pretreatment of wastewater, *Waste recovery, *Wastewater treatment, Aerobic digestion, Char, Chemical oxygen demand, Hydrogen ion concentration, Sugarcane, Temperature effects.

Stillage from cane molasses based alcohol distillery was thermally treated at 160 to 250 C at high pressure and in the absence of air. A solid charred residue was precipitated that was easily separated by gravity filtration from a liquid suitable for anaerobic digestion or wet oxidation. The charred residue was comparable with typical lignite coal in terms of carbon content and calorific value. Effects of temperature and pH on COD reduction, biodegradability, and filterability were reductions in COD from 100 kg/cu m to 78.5 kg/cu m at 160 deg and 40 kg/cu m at 250 C. At all temperatures COD attained a constant value after 2 h. Filterability of the residue obtained at higher temperatures also improved, while a decrease was demonstrated at higher pH's. Thermal pretreatment of stillage in reduction of COD is primarily due to physical separation of residue. Energy equivalent to COD reduction is obtained in the form of charred residue which can be used as fuel and lower COD in the stillage eliminates the need for dilution prior to aerobic digestion. (Doyle-PTT)
W91-05912

TREATMENT OF PENTACHLOROPHENOL-CONTAMINATED SOILS USING FENTON'S REAGENT.
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
R. J. Watts, M. D. Udell, and P. A. Rauch.
Hazardous Waste and Hazardous Materials HWHME2, Vol. 7, No. 4, p 335-345, Fall 1990, 8 fig, 2 tab, 27 ref. EPA Assistance Agreement R-814425-01-0 and NSF grant CES-8704878.

Descriptors: *Chemical treatment, *Cleanup, *Decontamination, *Fentons reagent, *Pentachlorophenol, *Soil contamination, Chlorinated aromatic compounds, Hydrogen ion concentration, Mineralization, Organic carbon, Oxidation, Reagents.

The Fenton's reagent (hydrogen peroxide and iron II) treatment of pentachlorophenol (PCP) was investigated as a basis for the on site and in situ treatment of contaminated surface soils. Mineralization of PCP was demonstrated in a silica sand system spiked with 250 mg/kg PCP, which was divided into 2.5 g aliquots and treated with 12.5 mL of 6.5% H2O2 and 1 mL of FeSO4 solution. The removal of the parent compound and total organic carbon with corresponding stoichiometric recovery of chloride was measured. The data show that greater than 99% of the original PCP was degraded in 24 h and that removal of total organic carbon closely followed PCP removal. The treatment of PCP was investigated in two natural soils of varying organic carbon content. Pentachlorophenol was degraded in soils with and without iron II addition. The optimum treatment conditions were found at pH2 to 3. (Doyle-PTT)
W91-05919

STUDIES ON INTERRELATIONSHIP BETWEEN DIFFERENT ANAEROBIC BACTERIA IN BIOGAS DIGESTER.
Shivaji Univ., Kolhapur (India). Dept. of Physics.
S. V. Kulkarni, and S. H. Godbole.
Current Science CUSCAM, Vol. 59, No. 12, p 603-605, June 25, 1990. 2 fig, 7 ref.

Descriptors: *Anaerobic bacteria, *Anaerobic digestion, *Biogas, *Digesters, *Farm wastes, *Methanogenesis, *Wastewater treatment, Methane bacteria, Nitrates, Redox potential, Sulfates.

A large variety of microorganisms are involved in production of methane by anaerobic digestion of organic matter. Sulfate-reducing and denitrifying bacteria are of particular importance since they have been reported to inhibit methanogenesis when sulfate and nitrate are available in the system. These bacteria have been reported to compete with methanogenic bacteria for their common substrates and thus inhibit methanogenesis. Studies on the interrelationship between methanogenic sulfate-reducing and denitrifying bacteria were carried out in an anaerobic biogas digester charged with a slurry of fresh cattle dung having a 10% total solid content. Most probable number of these bacteria, concentration of sulfate and nitrate in fermenting slurry, gas production, and redox potential were compared for 52 days. It was observed

that sulfate-reducing bacteria reduce initial sulfate content of the fermenting slurry to bring it to a low level and denitrifying bacteria help to establish the anaerobiosis by reducing the redox potential through utilization of nitrate. (White-Reimer-PTT)
W91-05945

DYNAMIC MODELING OF WASTEWATER TREATMENT PROCESSES.
Laval Univ., Quebec. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-05948

APPLICATION OF THE MASTER ANALYTICAL SCHEME TO THE DETERMINATION OF VOLATILE ORGANICS IN WASTEWATER INFLUENTS AND EFFLUENTS.
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5A.
W91-05955

5E. Ultimate Disposal Of Wastes

BACTERIAL LEACHING OF HEAVY METALS FROM SEWAGE SLUDGE-BIOREACTORS COMPARISON.
INRS-Eau, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5D.
W91-04943

ORGANIC CONTAMINANTS IN AN AGRICULTURAL SOIL WITH A KNOWN HISTORY OF SEWAGE SLUDGE AMENDMENTS: POLYNUCLEAR AROMATIC HYDROCARBONS.
Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.
S. R. Wild, K. S. Waterhouse, S. P. McGrath, and K. C. Jones.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1706-1709, November 1990. 2 fig, 5 tab, 30 ref.

Descriptors: *Hydrocarbons, *Organic pollutants, *Polycyclic aromatic hydrocarbons, *Sludge disposal, *Soil amendments, Agriculture, Biodegradation, England, Sludge analysis, Soil analysis, Woburn.

The polynuclear aromatic hydrocarbon (PAH) content of soils from a long-term agricultural experiment that received 25 separate sewage sludge applications from 1942 to 1961 is presented along with data from an untreated control plot and a plot that received repeated applications of farmyard manure. Archived plough layer (0-23 cm) soil samples were collected, stored and processed in the same manner between 1942 and 1984 and samples of the plowed layer were available for sample and analysis. Total soil PAH concentrations increased between 1942 and 1960 on the sludge-amended plot and subsequently showed a steady decline. By 1984 the sludge-amended plot still contained over three times more total PAH than the corresponding control soil. By 1960 70% of the total PAH load added in the sludge was unaccounted for; this had increased to nearly 85% by 1984. Some compound-specific trends are apparent in the data; generally, the higher molecular weight PAH's have been more persistent. It is argued that biodegradation and transboundary transfers due to ploughing are the two main loss mechanisms. (Author's abstract)
W91-04949

STOICHIOMETRY AND KINETICS OF THE REACTION OF NITRITE WITH FREE CHLORINE IN AQUEOUS SOLUTIONS.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04950

NEW YORK CITY'S PLAN TO END OCEAN DISPOSAL OF SLUDGE.
New York City Dept. of Environmental Protection. Bureau of Wastewater Treatment.
G. N. Lutzic, and P. A. Bender.
Public Works PUWOAH, Vol. 121, No. 11, p 66-67, October 1990. 1 fig.

Descriptors: *Future planning, *Land disposal, *New York City, *Ocean dumping, *Sludge disposal, *Waste disposal, *Waste management, Management planning, Privatization, Recycling, Regulations, Sludge drying.

To comply with the Ocean Dumping Ban Act of 1988, New York City is developing landbased methods of recycling its sewage sludge. The city generates 2.5 million gallons of sludge daily. By January 1992 the City is required of dewater and dispose (land-based) 20% of its sludge and 100% by June 1992. To meet this demand, the New York City Department of Environmental Protection is in the process of implementing a complex, multi-billion dollar land-based sludge management program. It involves the design and construction of eight dewatering facilities, the privatization of sludge management services and the establishment of sludge processing and disposal systems that will meet the city's needs for a generation to come. (Author's abstract)
W91-05028

CLASSIFICATION OF THE THERMAL REGIME OF HYDRAULIC-FILL STRUCTURES IN THE WINTER PERIOD OF OPERATION.
V. G. Panteleev, and A. N. Frolov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 36-40, 1990. 3 fig, 2 tab, 10 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 31-34, January, 1990.

Descriptors: *Ash disposal, *Hydraulic fill, *Mine wastes, *Soviet Union, *Waste disposal, Ash, Climates, Heat exchange, Hydraulic engineering, Sludge lagoons.

Hydraulic-fill dumps (e.g., ash dumps, tailings dams, and sludge storage ponds) operate continuously at any time of the year in various climatic regions of the Soviet Union. Two main problems arise when operating hydraulic ash disposal (HAD) systems at thermal power stations: (1) effective storage of the material without loss of reliability of the structure and (2) effective clarification of the water for reuse. Theoretical analyses and practical investigations were conducted with respect to thermal behavior in winter of more than 20 ash dumps in various climatic areas of the Soviet Union. Three types of dumps were recognized: (1) nonthermally loaded or 'cold' dump; (2) thermally loaded or 'warm' dump; and (3) moderately thermally dump. This classification is based on the character of heat exchange at its surface with the environment under extreme meteorological conditions and largely depends on the relationship between the amounts of incoming and dissipating heat. During winter operation, a dump that is characterized initially as a thermally loaded dump can be transformed into a cold dump due to heat loss in the recirculated water supply pipeline. More effective storage of industrial wastes and clarification of water is realized on hydraulic-fill dumps of the thermally loaded type and at the same time subsequent excavation of these dumps for using the wastes in the economy is facilitated. (Rochester-PTT)
W91-05084

HEAVY METAL BINDING BY THE POLYMERIC ORGANIC FRACTIONS OF SEWAGE SLUDGES.
Imperial Coll. of Science, Technology and Medicine, London (England). Public Health Engineering Lab.
N. K. Karapanagiotis, R. M. Sterritt, and J. N. Lester.
Environmental Pollution ENPOEK, Vol. 67, No. 3, p 259-278, 1990. 5 fig, 5 tab, 50 ref.

Descriptors: *Heavy metals, *Metal complexes, *Metal-organic complexes, *Sludge, *Sludge disposal, *Soil contamination, Cadmium, Copper, Digested sludge, Mixed liquor solids, Nickel, Zinc.

Organic complexes in sewage sludge play an important role in the speciation and transformation of metals into potentially more toxic and bioavailable forms. Two organic fractions, bacterial extracellular polymer and fulvic acid, were extracted from mixed liquor and digested sewage sludge. The homogeneity of the extracts was verified using gel permeation chromatography. Conditional stability constants and complexation capacities of the organic fractions from the sludges with copper, cadmium, nickel and zinc have been determined using equilibrium dialysis titration. Organic fractions from digested sludge demonstrated a greater capacity to complex metals over mixed liquor extracts. Copper formed stronger complexes than nickel with the mixed liquor biomass and cadmium exhibited the greatest affinity for digested sludge organic matter. It is concluded that the organic matter of very complex matrices, such as sludges, should be further characterized and fractionated before more reliable results can be obtained for metal-sludge binding studies. (Author's abstract)
W91-05115

ECONOMIC FEASIBILITY OF DRYING MUNICIPAL SOLID-WASTE COMBUSTION RESIDUE.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
M. Blaisdell, D. Lee, and B. Baetz.
Journal of Energy Engineering (ASCE) JLEED9, Vol. 116, No. 2, p 87-97, August 1990. 4 fig, 3 tab, 16 ref, append.

Descriptors: *Ash, *Feasibility studies, *Incineration, *Landfills, *Leachates, *Waste disposal, Cost analysis, Cost-benefit analysis, Economic aspects, Heat transfer, Municipal wastes.

Incineration of municipal solid waste (MSW) is increasing in many parts of the world. Waste incineration creates an ash residue that must be disposed of, typically in a solid-waste landfill. The ash often is water-quenched after incineration and may contain up to 50% moisture by weight. This moisture increases the weight of the ash sent to the landfill and the leachate load placed on the landfill's leachate collection. Current literature on MSW is reviewed, current ash handling practices are outlined, and the economic feasibility of ash-moisture reduction schemes are presented in the form of a cost-benefit analysis. Electric heating of the quenched bottom ash is shown to be an economically feasible scheme for moisture reduction. For current cost levels, the net yearly benefit may be as high as $1,200,000 for a typical 500 ton/day plant. The actual yearly benefit depends on a number of factors, including: heat transfer efficiency attainable in an ash dryer; cost of electricity; moisture content of the ash after quench and dewatering; percentage moisture reduction possible; disposal and transport costs; initial capital and maintenance cost; and discount rate. Further research and pilot plant studies are necessary to determine the optimum dryer type and configuration for maximum benefit. (Rochester-PTT)
W91-05123

STABILIZING COMPACTED CLAY AGAINST CHEMICAL ATTACK.
New Haven Univ., West Haven, CT. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W91-05128

WHAT SHALL WE DO WITH GARBAGE-DUMP AND LANDFILL LEACHATE.
For primary bibliographic entry see Field 5G.
W91-05156

DETERMINATION OF HEAVY METALS AND RADIOACTIVE ELEMENTS IN PURIFIER SLUDGE.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Chemistry.
P. Blanco, M. T. Ohms, J. M. Estela, and V. Cerda.
Journal of Environmental Science and Health (A)

JESEDU, Vol. 25, No. 7, p 855-868, October 1990. 2 fig, 4 tab, 12 ref.

Descriptors: *Sludge disposal, *Land disposal, Heavy metals, *Sludge analysis, *Radiochemical analysis, Emission spectrometry, X-ray fluorescence, Alpha spectrometry, Organic wastes, Heavy metals, Fertilizers.

The serious problems posed by environmental pollution in the last few years and the steady price increase of mineral fertilizers caused local authorities to study the use of organic wastes as fertilizers in agricultural farming. This particular study was made from a wastewater treatment plant in Sant Jordi, Palma de Mallorca, Spain. The concentration of heavy metal and radiochemical element contents of sludge from industrial (hotels) and domestic sources were analyzed by emission spectrography, X-ray fluorescence and alpha spectrometry. The results showed that none of the heavy metals and radiochemical elements in sludges from the treatment plant had concentrations above the maximum allowable limits. It is concluded that these sludges may therefore be safely used as fertilizers. (Medina-PTT)
W91-05209

HEALTH EFFECTS RESEARCH INITIATIVES AT THE AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY--APPLICABILITY TO CONTAMINATED SOILS.
Agency for Toxic Substances and Disease Registry, Atlanta, GA. Office of Health Assessment.
C. M. Harris.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 49-53, 2 ref.

Descriptors: *Water pollution effects, *Path of pollutants, *Superfund, *Waste disposal, *Public health, *Research priorities, *Toxicity, *Soil contamination, *Environmental effects, Hazardous wastes, Monitoring, Classification, Institutions, Research facilities.

The Agency for Toxic Substances and Disease Registry (ATSDR), part of the U.S. Public Health Service, was created to implement health measures mandated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (Public Law 96-510). ATSDR's mission is to prevent or mitigate adverse human health effects and the diminished quality of life resulting from environmental exposures to hazardous substances. CERCLA authorizes ATSDR to support generalized applied health effects research on toxic contaminants found at hazardous waste sites. CERCLA provided a congressional mandate to clean up abandoned hazardous waste sites, to provide federal aid in toxic emergency situations, and also mandates that ATSDR and EPA jointly rank, in order of priority, those substances that are most prevalent at Superfund sites and pose the greatest threat to human health. The primary criteria used in ranking these substances are: (1) overall toxicity of the substance (acute, subacute, and chronic toxicities); (2) frequency of occurrence; and (3) human exposure potential. The implementation of sponsored health effects research to fill significant data gaps concerning human exposure pathways, and the toxicity of substances commonly found at hazardous waste sites, is of high priority in accomplishing the global mission of ATSDR--service to the public through the mitigation and prevention of human exposure. (See also W91-05236) (Lantz-PTT)
W91-05242

FIELD-SCREENING TECHNIQUES: QUICK AND EFFECTIVE TOOLS FOR OPTIMIZING HAZARDOUS WASTE SITE INVESTIGATIONS.
Weston (Roy F.), Inc., Walnut Creek, CA.
For primary bibliographic entry see Field 5G.
W91-05246

STABILIZED PETROLEUM WASTE INTERACTION WITH SILTY CLAY SUBGRADE.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W91-05251

BIOREMEDIATION OF PETROLEUM CONTAMINATED SOILS USING A MICROBIAL CONSORTIA AS INOCULUM.
Solmar Corp., Orange, CA.
For primary bibliographic entry see Field 5G.
W91-05254

CUTOFF WALLS TO CONTAIN PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
M. D. Boscardin, and D. W. Ostendorf.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 233-250, 2 fig, 5 tab, 47 ref.

Descriptors: *Water pollution prevention, *Cutoffs, *Petroleum products, *Soil contamination, *Waste disposal, *Environmental protection, *Materials testing, Path of pollutants, *Barriers, Grouting, Liners, Bentonite.

A number of barrier materials and methods of construction are examined. Several barrier types appeared more suited to retain petroleum related contaminants than others. In general, permeation grouting appears to be a poor choice due to the difficulties in ensuring continuity of the barrier. Slurry wall construction techniques with the appropriate backfill or liner composition should perform satisfactorily. Plastic concrete backfill or a composite of backfill and membrane liner (HDPE or PVC) may be attractive alternatives. With the latter, difficulties with seaming and installation without tears or punctures will require special construction techniques and may hinder its use. Asphalt slurries, particularly those that include portland cement, may also provide satisfactory performance as a slurry trench backfill. In general, the bentonite-based backfills tend to fair poorly when faced with organic contaminants; however, proprietary mixes of treated bentonite may provide satisfactory performance under the appropriate conditions. Crucial factors for the success of barriers installed in situ, to surround a zone of contamination, are compatibility of the materials and the permeant (at the appropriate concentration), compatability of the construction techniques with the barrier materials, the ground conditions encountered, and good specifications and quality assurance controls for construction. (See also W91-05236) (Lantz-PTT)
W91-05255

COMPREHENSIVE ANALYSIS OF MIGRATION PATHWAYS (CAMP): CONTAMINANT MIGRATION PATHWAYS AT CONFINED DREDGED MATERIAL DISPOSAL FACILITIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5B.
W91-05269

GUIDANCE FOR CONTRACTING BIOLOGICAL AND CHEMICAL EVALUATIONS OF DREDGED MATERIAL.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
T. C. Sturgis.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report D-90-10, September 1990. Final Report. 127p, 5 fig, 4 tab, 39 ref, 10 append.

Descriptors: *Waste management, *Dredging wastes, *Waste disposal, *Standards, Field tests, Management planning, Decision making, *Pollutant identification, *Chemical analysis.

Contracting is a cost-effective method for increasing the capability of the Corp of Engineers to conduct dredged material evaluations. Test data generated by a contractor are used as an integral part of the decision making process by the Corp and the US EPA regarding the suitability of dredged material for disposal. Therefore, conscientious contract management is vital to ensure that the generated data are of the highest quality, are obtained in a competent fashion, and can be defended against legal scientific challenge. A general outline is provided of the various types of contractors, guidance on a variety of activities required for management of chemical and biological contracts, and quality assurance/quality control techniques specifically for dredged and fill material. (Author's abstract)
W91-05276

GENERALIZED LAGRANGIAN MODEL FOR BUOYANT JETS IN CURRENT.
Hong Kong Univ. Dept. of Civil and Structural Engineering.
For primary bibliographic entry see Field 8B.
W91-05323

CHARACTERIZING IN SITU STRESS DOMAINS AT THE AECL UNDERGROUND RESEARCH LABORATORY.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 8E.
W91-05362

WATER CONTENT-DENSITY CRITERIA FOR COMPACTED SOIL LINERS.
Texas Univ. at Austin. Dept. of Civil Engineering.
D. E. Daniel, and C. H. Benson.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 12, p 1811-1830, 1990. 17 fig, 1 tab, 18 ref.

Descriptors: *Landfill covers, *Water pollution prevention, *Lanfills, *Waste disposal, *Liners, Soil water, Soil density, *Clay liners, *Landfill liners, *Soil engineering, *Soil compaction, Environmental engineering, Waste disposal, Hydraulic conductivity, Compacted soils, Permeability, Soil properties.

Compacted soil is widely used to line landfills and waste impoundments, to cap new waste disposal units, and to close old waste disposal sites. Most engineers rely primarily on field-measured water contents and dry unit weights to verify proper compaction of the soil. Soil liners have traditionally been compacted in the field to a minimum dry weight over a specified range in water content. With soil liners, hydraulic conductivity is usually of paramount importance. Hence, the approach used to ensure adequate strength and permissible compressibility is not necessarily applicable to the construction of soil liners. The water content-density criteria for compacted soil liners can be formulated in a manner that is different from the approach currently used by many engineers. The recommended approach is based on defining water content-density requirements for a broad, but representative, range of compactive energy, and relating those requirements to hydraulic conductivity and other relevant factors. The procedure is: (1) soils are compacted over a range in water content using maximum, typical, and minimum compactive effort; (2) compacted specimens are permeated; (3) compaction data are plotted; (4) an acceptable zone is drawn that encompasses the test results meeting or exceeding the design criteria; and (5) the acceptable zone is modified to account for other factors that may be relevant to a given project. A case history illustrates the recommended procedure and its implementation. Hydraulic conductivity measurements were performed on three soils to develop an 'acceptable zone' on the compaction curve that was used for quality control during construction. As a result of implementing the recommended procedure, construction operations were significantly accelerated. (Fish-PTT)
W91-05379

BIODEGRADATION OF LAND-APPLIED SLUDGE.
Harvard Univ., Cambridge, MA. Lab. of Microbial Ecology.
M. Boyle.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 640-644 , Oct-Dec 1990. 2 tab, 36 ref. US EPA grant CR-812699.

Descriptors: *Biodegradation, *Decomposing organic matter, *Land disposal, *Microbial degradation, *Sludge disposal, *Waste disposal, Economic aspects, Heavy metals, Sludge digestion, Sludge treatment, Soil organisms, Toxicity.

In the last 20 years, land application of both activated and digested sludge has received a renewed interest because of the high energy cost of incineration and the phasing out of ocean dumping. Before we can design better methods for land disposal or 'engineer' better microbial decomposers, the limitations of sludge decay must first be addressed. There is a need to increase the rate of decomposition during and after sludge formation. The means of sludge formation often determines which environmental factors and enzymatic reactions are effective in further degrading this complex substrate. Municipal sludges contain relatively high concentrations of heavy metals from industrial discharge and residential plumbing. The soil/plant system is usually a good barrier to human exposure from toxic components within sludge. When sludge is applied to land there is an initial flush of microbial activity. The microbial biomass decreases as the easily degradable materials from the initial substrate and microbial metabolites are mineralized. During humification, sludge undergoes extensive reduction in soluble carbon, cellulose, and hemicellulose complexes along with a relative increase in the proportion of lignin. As the composition of the organic material shifts with time presumably the microbial decomposer community also changes. (Doyle-PTT)
W91-05392

NITROGEN MINERALIZATION AND ELEMENTAL AVAILABILITY IN SOILS AMENDED WITH COCOMPOSTED SEWAGE SLUDGE.
Delaware Univ., Newark. Dept. of Plant Science.
J. T. Sims.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 669-675, Oct-Dec 1990. 3 fig, 7 tab, 31 ref.

Descriptors: *Composting, *Nitrogen, *Sludge disposal, *Soil amendments, *Waste disposal, Fertilizers, Land disposal, Mineralization, Nitrogen fixation, Nutrient transport, Sludge utilization, Soil chemistry.

Land application of cocomposted sewage sludge (CCSS), produced by the aerobic digestion of municipal refuse and anaerobically digested sewerage sludge, represents an alternative use for organic wastes that are currently landfilled, incinerated, or disposed of by ocean dumping. Laboratory and greenhouse studies were conducted with four types of CCSS to determine their suitability for agricultural use, based on mineralizable N and the availability of plant nutrients and certain nonessential heavy metals (Cd, Cr, Ni, Pb). Nitrogen mineralization studies, conducted for 20 wk with three soils amended with 22 Mg/ha of each CCSS type (total N added = 250 to 398 kg N/ha), indicated that immobilization of N could be a serious problem with these composts. Negative values, ranging from -7 to -39 mg/kg, were obtained for net N mineralization (N mineralized adjusted for inorganic N added in the CCSS and mineralized soil N). Additionally , wheat (Triticum aestivum L.) plants grown in the greenhouse for 8 wk with the sam CCSS applied at rates of 0, 11, 22, and 44 Mg/ha, and supplemented with 100 mg/kg of N as NH4NO3, exhibited N deficiency symptoms, reduced dry matter production, and lower plant N concentrations of P, K, Ca, Mg, Cu, Cd, Cr. Ni and Pb were noted among CCSS types in the greenhouse study. The CCSS rate also had little influence on plant and soil concentrations of these elements. Soil pH, however, was increased by lime-amended CCSS, resulting in significant decreases in plant concentrations of Mn and Zn. In summary, results from laboratory and greenhouse studies suggest that, when applied at agronomic rates, these composts can produce satisfactory plant growth, if adequate amounts of supplemental N fertilizers are applied, and that increases in soil and plant concentrations of nonessential heavy metals should not be a limiting factor in compost use. (Author's abstract)
W91-05397

DENITRIFICATION IN POROUS MEDIA DURING RAPID, CONTINUOUS LEACHING OF SYNTHETIC WASTEWATER AT SATURATED WATER FLOW.
Hiroshima Univ. (Japan). Faculty of Engineering.
For primary bibliographic entry see Field 5D.
W91-05398

NITROGEN STATUS OF FOREST FLOOR, SOILS, AND VEGETATION FOLLOWING MUNICIPAL WASTEWATER SLUDGE APPLICATION.
Naval Facilities Engineering Command, Pearl Harbor, HI. Pacific Div.
S. G. Aschmann, M.S. McIntosh, J. S. Angle, R. L. Hill, and R. R. Weil.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 687-694, Oct-Dec 1990. 3 fig. 6 tab, 21 ref.

Descriptors: *Enrichment, *Fertilizers, *Forest soils, *Land application, *Municipal wastewater, *Nitrogen, *Sludge disposal, Deciduous forests, Maryland, Nitrification, Nutrient transport, Soil chemistry.

As available agricultural land decreases in the Northeast, the feasibility of applying sludge to established hardwood forests is increasingly being considered. A major concern with this practice is the potential for the large quantities of nitrogen in sludge to be detrimental to the forest ecosystem. In June 1986, aerobically digested liquid sludge was surface applied to a Maryland hardwood forest at rates of 0, 3, 6, and 12 dry Mg/ha, corresponding to nitrogen loadings of 0, 200, 400, and 800 kg N/ha, respectively. Soils from the 0 to 10 and 10 to 20 cm soil depth were analyzed for extractable NO3-N and NH4-N in the spring and fall of 1986 and 1987. Standing litter, litterfall, and leaves of five overstory and seven understory species were analyzed for total nitrogen annually. The first year following sludge application, total extractable nitrogen in the surface 10 cm of soil ranged 28 mg/kg soil in the control to 125 mg/kg under the 800 kg N/ha treatment. With in two years, total extractable N in the soil surface was not significantly different among treatments. Nitrogen concentration in litterfall increased with increasing sludge rates but only during the second year after sludge was applied. Nitrogen in the standing litter of the 800 kg N/ha increased in response to sludge the first year of application, indicating that decomposition was accelerated in sludge treated plots. The second year after sludge application, foliar nitrogen concentration was increased with increasing sludge rate in two of five tree species and four of seven understory species. The total nitrogen uptake was small compared with the total available nitrogen. Low rainfall in 1986 and 1987 may have limited nitrogen uptake by the vegetation. (Doyle-PTT)
W91-05400

LONG TERM SWINE LAGOON EFFLUENT APPLICATIONS ON 'COASTAL' BERMUDAGRASS: I. YIELD, QUALITY, AND ELEMENT REMOVAL.
North Carolina Agricultural Research Service, Raleigh.
For primary bibliographic entry see Field 5D.
W91-05405

LONG-TERM SWINE LAGOON EFFLUENT APPLICATIONS ON 'COASTAL' BERMUDAGRASS: II. EFFECT ON NUTRIENT ACCUMULATION IN SOIL.
North Carolina State Univ., Raleigh. Dept. of Soil Science.
L. D. King, J. C. Burns, and P. W. Westerman.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 756-760, Oct-Dec 1990. 5 fig, 8 ref.

Descriptors: *Bermudagrass, *Fertilizers, *Hogs, *Land disposal, *Land treatment, *Manure, *Soil chemistry, *Wastewater disposal, *Wastewater lagoons, *Water pollution effects, Holding ponds, Nitrates, Nutrient concentrations, Phosphates, Runoff, Soil cores, Surface-groundwater relations.

Application of effluent from animal manure lagoons to cropland is an effective method of utilizing the nutrients in the effluent and minimizing groundwater and surface-water pollution. The effect of land application of effluent from a swine manure lagoon on selected soil chemical properties was studied over an 11 yr period. Effluent was applied at rates to supply approximately 335, 670, and 1340 kg of N/ha/yr to 'coastal' bermudagrass (Cynodon dactylon) on a Paleudult soil from 1973 to 1983. Soil cores taken to a depth of 210 cm were analyzed for H2O-extractable NO3-N and Mehlich 1-extractable P and cations. Nitrate-N concentrations (1-5 mg/kg) with the two lower rates were similar to concentrations where no effluent was applied. At the high effluent rate, NO3-N concentrations were elevated, particularly in the subsoil, and 540 kg NO3-N was present in the profile. Phosphorus increased with loading rate and at the high rate, P concentrations (450 mg/kg) in the 0 to 15 cm zone was 10 times the level above which no response to P fertilization would be expected. Potassium concentration increased with loading rate throughout the profile. Magnesium accumulation was inversely related to effluent loading rate in the 0 to 15 cm zone, but accumulation in the subsoil was directly related to loading rate. Comparison of profile nutrient distributions at the high rate for Years 6 and 11 showed no appreciable accumulation of NO3-N during the period. Accumulation of the nutrients during this 5 yr period was P, 210%, K, 200%, Ca, 140%, Mg, 60%, and Na, 10% as compared with Year 6. Soil pH was decreased by the high effluent rate but did increase from 4.2 at Year 6 to 5.0 at Year 11 due to the increased rate of application of basic cations during that period. The high rate poses a groundwater pollution hazard because of the large quantity of NO3-N present in the profile. In previous years, appreciable NO3-N was also present at the medium rate, but NO3-N was low at this rate in Year 11. The high P concentrations in the surface soil increase the potential for runoff transport of P, which might pose a surface-water pollution problem. (See also W91-05405) (Author's abstract)
W91-05406

INFLUENCE OF DETERGENT FORMULATION ON NUTRIENT MOVEMENT THROUGH SAND COLUMNS SIMULATING MOUND AND CONVENTIONAL SEPTIC SYSTEM DRAINFIELDS.
Geraghty and Miller, Inc., Raleigh, NC.
For primary bibliographic entry see Field 5B.
W91-05415

INTERFACIAL MIXING CAUSED BY TURBULENT BUOYANT JETS.
Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
For primary bibliographic entry see Field 8B.
W91-05419

HEAVY-METAL UPTAKE FROM THE FREIBURG WASTEWATER FIELD BY GARDEN VEGETABLES (SCHWERMETALLAUFNAHME VON GARTENPFLANZEN DER FREIBURGER RIESELFELDER).
Freiburg Univ. (Germany, F.R.). Inst. fuer Bodenkunde und Waldrnaehrungslehre.
P. Truby, and A. Raba.
Agribiological Research, Vol. 43, No. 2, p 139-146, 1990. 7 tab, 10 ref. English summary.

Descriptors: *Agriculture, *Germany, *Heavy metals, *Irrigation, *Soil contamination, *Vegetable crops, *Wastewater utilization, Cadmium,

Comparative studies, Lead, Plant growth, Variability, Zinc.

The use of wastewater from the city of Freiburg for irrigation resulted in an enrichment of heavy metals in the soil. The Zn, Cd, and Pb-uptake of different plant species was determined by a field experiment. Data for the Zn and Cd-contents of leaf and root vegetables were in general relatively high when compared to data from other investigations. The standard values established by ZEBS in 1986, were often significantly exceeded. Fruit and vegetables were found to have low heavy metal concentrations. However, lettuce, mangold, spinach, celeriac and carrot grown on a neighboring uncontaminated field also had high Cd concentrations. This resulted from a non optimal plant growth and a high annual variation in the uptake. These factors can have a greater influence on the heavy metal uptake than the soil content. Therefore it is not possible to predict the uptake of heavy metals by garden vegetables on the basis of the soil content. (Author's abstract)
W91-05474

CADMIUM ADSORPTION BY SEWAGE SLUDGE-TREATED SOIL AFTER DIFFERENT WETTING AND DRY CYCLES.
Akademia Techniczno-Rolnicza, Bydgoszcz (Poland).
I. Szymura, L. Lubrano, B. Pezzarossa, and G. Petruzzelli.
Agrochimica AGRCAX, Vol. 34, No. 1/2, p 111-116, 1990. 1 fig, 1 tab, 6 ref.

Descriptors: *Agriculture, *Cadmium, *Heavy metals, *Path of pollutants, *Sludge, *Sludge disposal, *Soil chemistry, Absorption, Acidification, Drying, Seasonal variation, Soil organic matter, Soil types, Wetting.

The adsorption of cadmium by a soil treated with sewage sludge and subjected to one and five wetting and drying cycles was investigated. The wetting and drying procedure which resembles the variation in the soil properties over the course of a growing season in the field, affects some parameters related to heavy metal absorption. In particular, the process could be associated with an increase in surface acidity. A slight, but significant, decrease in soil pH was found in both soil samples. The decrease was more evident in the treated soils (pH 7.0 to 6.2), and was near to the value of the original soil (pH 6.1). Wetting and drying cycles decreased the cadmium adsorption by the soil, as reflected by the Langmuir parameters, probably due to the surface acidity induced by this process. The addition of organic materials enhanced the absorptive capacity of the soil. Sewage sludge increased the number of surfaces which react with the metal. The results obtained highlight the importance of different phenomena related not only to sewage-sludge addition to agricultural soils, but also to variations in some soil parameters that are influenced by the wetting and drying process. (Agostine-PTT)
W91-05479

INDOLACETIC ACID PRODUCTION FROM OLIVE WASTE WATER BY ARTHROBACTER SPP.
Istituto di Radiobiochimica ed Ecofisiologia Vegetale, Rome (Italy).
U. Tomati, G. Di Lena, E. Galli, A. Grappelli, and R. Buffone.
Agrochimica AGRCAX, Vol. 34, No. 3, p 223-228, May/June 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Bacteria, *Bacterial physiology, *Industrial wastewater, *Wastewater utilization, Biomass, Biosynthesis, Microorganisms, Olive oil, Organic compounds, Phenols.

Olive oil wastewater is a material rich in organic compounds. The organic matter responsible for the polluting effect could be considered as a feasible source for biomass production. The possibility of obtaining biologically active substances by Arthrobacter spp. was investigated. Four strains of Arthrobacter (A. globiformis NCIB8602, A. viscosus NBIC9728, A. fluorescens DSM3680, and A. giacomelloi DSM3681) were tested. The high content of phenolic compounds present in olive oil wastewater is a limiting factor for its use in bacterial biomass production, since phenols have an inhibiting effect on microbial growth. Although Arthrobacter are among the microorganisms able to metabolize phenols, the four strains used reacted differently when cultured in olive oil wastewater. A. giacomelloi and A. viscosus were found to be suitable for indolacetic acid (IAA) production. The addition of tryptophan enhanced biomass production while greatly enhancing IAA biosynthesis. The phenol concentration was a limiting factor for biomass production. During their growth, all microbial strains strongly reduced the phenol content in the cultural medium. (Agostine-PTT)
W91-05483

SEWAGE SLUDGE UTILIZATION TECHNOLOGY IN TOKYO.
Tokyo Sewerage Bureau (Japan). Engineering Research and Development Section.
Y. Yasuda.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1743-1752, 1991. 5 fig, 7 tab.

Descriptors: *Compost, *Japan, *Recycling, *Sludge disposal, *Sludge treatment, *Sludge utilization, *Tokyo, *Waste utilization, Ash, Composting, Organic matter, Slags, Sludge drying, Sludge solids, Waste management, Waste solidification, Wastewater disposal.

As an increasing quantity of sewage sludge is produced in Tokyo, it has become difficult to acquire enough land for sewage sludge disposal. Therefore, efforts have been made to develop sewage sludge utilization technologies. Five such technologies are conversion of sewage sludge to compost, conversion of sewage sludge to fuel, production of artificial light-weight aggregate from ashes, press burning of incineration ashes, and conversion of sewage sludge to melted slag. Converting sewage sludge to compost and to fuel utilizes the organic matter in sewage sludge. Good results have been obtained composting sewage sludge. A full-scale facility with a compost production capacity of 2-3 ton/day was constructed at the Minami Tama Wastewater Treatment Plant. Because sewage sludge cannot normally be used as fuel due to its moisture content, the Tokyo Metropolitan Government developed an efficient drying method whereby the fuel production process became practical. A sludge drying facility was constructed in 1989 and is currently operating on a trial basis. The inorganic matter in sewage sludge is utilized by converting sludge ashes to an artificial lightweight aggregate, press burning of ashes and converting sludge to melted slag. The Tokyo Metropolitan Government began research on sewage sludge ash utilization technology in 1974 and currently operates a facility that produces 3 ton/day of lightweight aggregate. Sludgelight, as the product in called, is appropriate for manufacturing baked products; press burning of sewage sludge ashes produces bricks. A facility is under construction at the Nambu Sludge Plant that will process 10 ton of sludge/day. The facility should begin operations in 1990. (Mertz-PTT)
W91-05501

REVIVAL OF INCINERATION IN THE UK.
AQUA-ENVIRO, Wakefield (England).
For primary bibliographic entry see Field 5D.
W91-05507

EFFECTIVENESS OF EVAPOTRANSPIRATION SYSTEMS IN DISPOSING OF WASTEWATER IN REMOTE ABORIGINAL COMMUNITIES IN NORTHWEST AUSTRALIA.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
D. R. McGrath, G. E. Ho, and K. Mathew.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1825-1833, 1991. 2 fig, 20 ref.

Descriptors: *Evapotranspiration, *Evapotranspiration potential, *Plant-water relationships, *Wastewater disposal, Australia, Eucalyptus, Evaporation, Evaporation pans, Grasses, Gravel, Hydrologic equation, Lysimeters, Water loss.

The outstation movement, where Aboriginal people in remote areas of Australia are returning to their ancestral lands, has resulted in the development of many new communities. Health problems rising from ineffective waste disposal systems and a lack of maintenance of existing systems are prevalent in many of these communities. Evapotranspiration systems have potential for use in those areas where soil absorption fields fail. The systems cost considerably less and potentially require less maintenance than reticulated systems. The effectiveness of evapotranspiration systems in disposing of wastewater, and the application of these systems to remote Aboriginal outstations was investigated. Evapotranspiration system sizing requirements were determined with the water balance equation. Water loss from lysimeters planted in tanks with trees (Eucalyptus camaldulensis) or lawn grass, and from bare soil and gravel was monitored over several months and compared to pan evaporation measured during the same period. It was found that evapotranspiration from bare soil and grass followed similar trends to pan evaporation, ranging from 30-60% of pan evaporation for soil and from 60-80% of pan evaporation for grass. Evapotranspiration rates increased in the tanks planted with trees as the plants grew and exceeded pan evaporation rates. Evaporation from gravel-filled lysimeters was low; as little as 10% of pan evaporation. (Mertz-PTT)
W91-05510

EFFECT OF STRIP BED ROUGHNESS ON THE REAERATION RATE COEFFICIENT.
Sao Paulo Univ., Sao Carlos (Brazil). Dept. de Hidraulica e Saneamento.
For primary bibliographic entry see Field 5G.
W91-05521

SEWAGE SLUDGE COMPOSTING PROCESS BY STATIC PILE METHOD.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
H. Ishii, K. Tanaka, M. Aoki, T. Murakami, and M. Yamada.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1979-1989, 1991. 8 fig, 3 tab, 3 ref.

Descriptors: *Composting, *Sludge treatment, *Sludge utilization, *Static pile composting, *Wastewater disposal, Aeration, Biological oxygen demand, Fertilizers, Moisture content, Sludge drying, Soil amendments, Temperature, Wastewater treatment.

Sewage sludge is considered to be a promising fertilizer and soil conditioner. Since dewatered sludge might cause some problems in its direct application onto fields it is recommended that dewatered sludge be treated aerobically before application by composting. Dewatered raw sludge with polymer was composed without any bulking agents by using recycled compost to preadjust the moisture content of the dewatered sludge. Approximately 6 tons of mixture was piled on the floor to be composted. The aeration methods employed were natural ventilation and intermittent aeration. Results of the static pile composting process revealed that the moisture content of the feed mixture, which was dewatered sludges and recycled composts, was lowered to approximately 50%. This allowed the raw sludge to be composted by either natural ventilation or intermittent aeration. When the biological oxygen demand of feed mixture was lower than 50 g/kg of dewatered sludge the fermentation temperature did not reach 60 C and the moisture content of the mixture was not lowered during composting period. The required composting time was approximately 50 days for natural ventilation (at an average temperature of 10 C or 24 C) and approximately 35 days for intermittent aeration, when the moisture content of finished compost was 40% and the biological oxygen demand was 30 g/kg dewatered sludge or less. There was a highly positive correlation between the amount of water evaporated and the amount of biological oxygen demand removed.

This result suggested that the amount of water evaporation could be reduced. (Mertz-PTT)
W91-05526

ESTIMATION OF ENERGY SAVING FOR MELTING PROCESS ON SEWAGE SLUDGE.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
T. Murakami, K. Sasabe, K. Sasaki, and T. Kawashima.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2011-2018, 1991. 6 fig, 2 ref.

Descriptors: *Energy use efficiency, *Incineration, *Melting, *Sludge disposal, *Sludge treatment, *Wastewater disposal, Cost savings, Energy conservation, Moisture content, Slags, Sludge melting, Temperature, Wastewater treatment.

The possible volume reduction and stabilization of the sewage sludge associated with the melting process are expected to be greater than with the incineration process. In addition, melted slag can be utilized. However, since the melting process requires a very high temperature to melt inorganics (ash) in the sludge, the technologies to minimize energy consumption, to establish system operation and to prolong durability of facilities need to be developed. A model was prepared that provides the auxiliary fuel consumption of the melting system on the basis of the mass and heat balances. Evaluation the auxiliary fuel consumption in the model used the cake moisture content, the volatile solids of the cake, the dried cake moisture content, and the melting temperature as parameters. Operational conditions for an energy saving melting system were examined. The experiment showed that the quantitative treatment of heat did not cause any problems in a temperature range of up to 1600 C in the melting furnace. Moisture content of dewatered cake fed to the drying unit had a large effect on the auxiliary fuel consumption. For example, reducing moisture content from 80-75% resulted in a 25% reduction in the water volume. It was preferable that the moisture content of dewatered cake be low enough in the melting furnace to maintain the melting temperature without auxiliary fuel. A greater ignition loss meant a lower fuel consumption. High basicity required a higher melting temperature, and that resulted in higher auxiliary fuel consumption. Electricity, water and chemicals should be considered as utilities for the melting process in addition to an auxiliary fuel. This will be studied in the future. (See also W91-05530) (Mertz-PTT)
W91-05529

CHARACTERISTICS OF MELTING PROCESS FOR SEWAGE SLUDGE.
Japan Sewage Works Agency, Toda. Research and Technology Development Div.
T. Murakami, T. Ishida, K. Sasabe, K. Sasaki, and S. Harada.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2019-2028, 1991. 9 fig, 4 tab, 4 ref.

Descriptors: *Incineration, *Melting, *Sludge disposal, *Wastewater disposal, Ash, Construction materials, Enthalpy, Fuel, Moisture content, Phosphoric acid, Sludge, Sludge utilization, Temperature.

The development of melting process techniques in the sewage works can make possible the utilization of sewage sludge as construction materials. Since the pouring temperature affects the runoff of melting ash, the heat resistance of reactor wall materials, and the quantity of heat-loss from reactors, it is a crucial factor for planning and designing the melting system. On the other hand, the moisture content, the calorific value, and the organic matter content of sludge greatly affect the auxiliary fuel consumption since the sludge melting process is operated at a high temperature. Ash components of sewage sludge were measured and analyzed, the fall of the pouring temperature on sewage sludge was estimated from various points of view and heat values of sewage sludge were measured. There were three effective parameters for the auxiliary fuel consumption in the melting process: ignition loss, moisture content of sludge and temperature. The estimation model showed that the lowering of the pouring point temperature was most effective for the auxiliary fuel saving on the melting process. The ash component in the sludge is similar to natural rock except for a higher ratio of phosphoric acid content. The index of the basicity is suitable at around 1.0. In using the experimental three-component status graph, two ranges where the pouring point temperature decreases have been found. A comprehensive equation was proposed such that the calorific value of sludge could be expressed as a function of the ignition loss. (See also W91-05529) (Mertz-PTT)
W91-05530

SLUDGE MELTING PROCESS WITH HAZARDOUS ASBESTOS WASTES.
Kyoto Univ. (Japan). Environment Preservation Center.
S. Sakai, H. Takatsuki, M. Hiraoka, and T. Tsunemi.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2029-2037, 1991. 5 fig, 3 tab, 17 ref.

Descriptors: *Asbestos, *Hazardous wastes, *Incineration, *Melting, *Sludge disposal, *Wastewater disposal, Ash, Construction materials, Environmental effects, Slags, Sludge utilization, Temperature.

Sewage sludge melting has been developed and operated in full-scale plants for sludge processing and utilization of the by-products as construction materials. Hazardous asbestos wastes should be disposed of properly so as not to lead to environmental pollution. The co-melting process for sewage sludge and asbestos wastes is examined based on the basic melting behavior of asbestos and a laboratory plant experiment. Microscopic observation and X-ray diffraction analysis showed that asbestos forms could be changed physically and chemically by the high temperature melting. The disappearance of asbestos fibrous forms and chemical changes of its composition in the melted slag are not always concluded to be non-toxic, but considering that the melted slag is a rock-like material with high strength, the melting is acceptable as a method of hazardous asbestos waste disposal. Laboratory scale experiments have been conducted on co-melting disposal of sprayed-on chrysotile asbestos waste and a mixture of lime-added and polymer-added sewage sludge. It was possible to maintain the temperatures around 1600 C and to discharge slag smoothly. It is also expected that asbestos cement wastes will contribute to the adjustment materials of basicity (CaO/SiO_2) in the polymer-added sludge melting. (Author's abstract)
W91-05531

GROUND WATER RECHARGE WITH SEWAGE EFFLUENT.
Agricultural Research Service, Phoeniz, AZ. Western Cotton Research Lab.
For primary bibliographic entry see Field 3C.
W91-05538

WASTEWATER DISPOSAL BY SUB-SURFACE TRICKLE IRRIGATION.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
For primary bibliographic entry see Field 3C.
W91-05544

CHEMICAL RECLAMATION OF SALINE-SODIC SOILS OF THE LOWER DON FLOODPLAIN BY SOME INDUSTRIAL WASTES.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W91-05576

USE OF A REMOTE OPERATED VEHICLE (ROV) TO EVALUATE MARINE DISCHARGES OF TREATED WASTEWATER.
Metcalf and Eddy, Inc., Wakefield, MA.
For primary bibliographic entry see Field 7B.
W91-05663

CALIFORNIA LAND BAN OF METAL-CONTAINING AQUEOUS WASTES.
California Dept. of Health Services, Sacramento. Alternative Technology Section.
For primary bibliographic entry see Field 5G.
W91-05672

HEAVY METAL WASTE CONVERSION BY THERMALLY-DRIVEN CHEMICAL BONDING.
Ceramic Bonding, Inc., Mountain View, CA.
B. A. Johnson, C. B. Rubenstein, R. J. Martin, and J. O. Leckie.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 289-297. 3 tab, 7 ref.

Descriptors: *Chemical treatment, *Hazardous wastes, *Heavy metals, *Metal-finishing wastes, *Sludge treatment, *Waste treatment, Industrial wastes, Metals, Recycling, Solid wastes, Waste management, Waste utilization.

A new technology for on-site conversion of hazardous, heavy-metal wastes to ceramic construction materials involves high temperature physical-chemical bonding of metals into naturally occurring alumina-silicates, to produce a non-soluble, non-leachable ceramic aggregate. The process is accomplished in two stages: proportioning and mixing of the additive material with the metal sludge; and thermal processing. Samples of three industrial metal sludges were subjected to the bonding process and analyzed for solubilities in weak and strong acids. Thermal processing of a spent nickel plating bath resulted in a 98% reduction in cobalt, nickel and zinc extractable by weak acid. Two other waste samples had 85-97% reductions in the amounts of chromium, copper, and zinc extracted by strong acid after treatment. Physical analysis of the ceramic aggregates indicated that the specific surface area was between 0.3 and 6 sq.m/g and that the material contained pores which were not interconnected. Results indicate that the ceramic aggregate may be suitable for use as concrete sand and for blending into a manufactured ceramic product. (See also W91-05668) (MacKeen-PTT)
W91-05684

HYDROMETALLURGICAL RECYCLING OF METAL SLUDGE.
Recontek, Inc., San Diego, CA.
S. W. Rosenbaum.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 304-309. 2 fig.

Descriptors: *Hazardous wastes, *Heavy metals, *Metal-finishing wastes, *Recycling, *Sludge treatment, *Waste recovery, *Waste treatment, Industrial wastes, Metallurgy, Metals, Solid wastes, Waste management.

A hydrometallurgical process for the extraction of metals from metal hydroxide sludges relies upon sulfuric acid extraction, followed by filtration, and then distillation to remove chlorides, borates or nitrates. Iron is removed by conversion to jarosite; copper recovery is by electrowinning. Cadmium, zinc, and subsequently nickel are removed by precipitation with zinc. The zinc-rich electrolyte is electrowon for zinc, after which the sulfuric acid-rich solution is returned to dissolve the next batch of sludge. A comparison of disposal costs of metal sludge revealed that hydrometallurgical recycling ($195/ton) was significantly less expensive than land disposal ($485/ton). A pilot facility at San Diego, California, has conducted the major components of the process at 1/10 (2 ton) scale. Full scale facilities are under construction or planned for Illinois, Florida, Arizona, and Indiana. (See also W91-05668) (MacKeen-PTT)
W91-05686

RECYCLING AND TREATMENT OF METAL-BEARING SPENT ACIDS.
Battelle Pacific Northwest Labs., Richland, WA.
E. O. Jones, and T. L. Stewart.

IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 311-319. 1 fig, 4 tab, 8 ref.

Descriptors: *Hazardous wastes, *Heavy metals, *Industrial wastes, *Metal-finishing wastes, *Recycling, *Waste recovery, *Waste treatment, *Wastewater treatment, Acids, Copper, Uranium, Waste management, Zirconium.

Three wastes generated during nuclear fuel fabrication were chosen for testing a method for the reduction of waste from metal-bearing spent acids generated during metal refining, refinishing and electroplating operations: (1) milling solution, containing nitric and sulfuric acids with uranium as the major impurity; (2) etch solution, containing hydrofluoric and nitric acids with zirconium as the major metal impurity; and (3) strip solution, containing nitric acid with copper as the major metal. The method uses oxalic acid for precipitation of Cu and sodium fluoride for precipitation of Zr. Distillation is used for reclaiming the U containing acid streams and for concentrating acids from stripping and etching operations once detoxification and recycling are no longer possible. The design flow rate of the pilot-scale test system is 900 L/day. Tests of the method have indicated the following: 85% recovery of Cu and Zr; 80% recovery of nitric acid; and 40% or greater reduction in waste volume. It is concluded that similar recoveries can be expected from other metal-bearing spent acids. (See also W91-05668) (MacKeen-PTT)
W91-05687

DEMETALLATION AND RECOVERY OF FUEL OIL FROM HAZARDOUS WASTE OIL.
Auburn Univ., AL. Dept. of Chemical Engineering.
N. Dhuldhoya, A. R. Tarrer, and W.-T. Wu.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 320-328. 5 fig, 5 tab, 8 ref.

Descriptors: *Chemical treatment, *Hazardous wastes, *Heavy metals, *Metal-finishing wastes, *Oil recovery, *Waste recovery, *Waste treatment, Automotive industry, Industrial wastes, Lead, Recycling, Sludge, Waste management.

In a recently-developed chemical method for the removal of metals from waste oil, reaction of diammonium phosphate (DAP) with organometallic compounds in waste oil forms metal hydroxyl phosphates in the interfacial region. The amount of DAP required to treat a waste oil was found to depend upon the ash content of the oil. Triethanolamine (TEA) added to the reaction mixture was found to aid in lead removal and to remove sludge effectively. Oil recovery was found to increase with increasing settling time and with increasing temperature. More than 85% reductions in ash and lead content were obtained by treating waste oil with 1 wt% DAP and 0.5 wt% TEA for one hour at 80 C under atmospheric pressure. The development of a pilot plant for waste oil recovery with a capacity for treatment of 5 gal/min is underway. (See also W91-05668) (MacKeen-PTT)
W91-05688

DENITRIFICATION OF LANDFILL LEACHATE BY THE MODIFIED ROTATING BIOLOGICAL CONTACTOR (RBC).
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 5D.
W91-05755

STEADY FLUID FLOW AND TRAVEL TIMES IN PARTIALLY SATURATED FRACTURES USING A DISCRETE AIR-WATER INTERFACE.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W91-05837

ODOUR AND AMMONIA EMISSIONS FOLLOWING THE SPREADING OF ANAEROBICALLY-DIGESTED PIG SLURRY ON GRASSLAND.
AFRC Inst. of Grassland and Animal Production, Hurley (England).
B. F. Pain, T. H. Misselbrook, C. R. Clarkson, and Y. J. Rees.
Biological Wastes BIWAED, Vol. 34, No. 3, p 259-267, 1990. 4 tab, 18 ref.

Descriptors: *Agricultural practices, *Anaerobic digestion, *Fertilizers, *Land disposal, *Odor control, Ammonia, Emission control, England, Fatty acids, Grasslands, Nitrogen, Slurries.

The number of complaints about odors arising from agricultural practices in the UK has been increasing since the 1960s. Pig production is the major source of complaints, almost half of the total number of complaints from the practice slurry and manure spreading. Anaerobic digestion might be expected to reduce the odor offensiveness of pig slurry; however, there is little objective, quantitative data to show that the process reduces the concentration of odors emitted when slurries are spread on land. During slurry spreading, nitrogen is lost to the atmosphere by ammonia volatilization, which represents a reduction in the fertilizer value of the slurry, and may cause damaging environmental effects from ammonia emissions. Anaerobically digested and untreated pig slurries were spread on grassland plots and measurements of odor and ammonia emissions were made using a system of small wind tunnels. It was found that digestion reduced total solids, total nitrogen, and volatile fatty acid content of pig slurry and increased pH value. Odor emission during the first 6 h following application was reduced by between 70-80%. Odor intensity was also reduced, but odor offensiveness, when measured at the same intensity, was unchanged. Digestion had no significant effect on the ammonia volatilization from pig slurry following application to grassland. (Fish-PTT)
W91-05847

COMBINING INDUSTRIAL WASTES WITH LIME FOR SOIL STABILIZATION.
Kyoto Univ. (Japan). Dept. of Civil Engineering.
M. Kamon, and S. Nontananandh.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 1, p 1-17, January 1991. 11 fig, 8 tab, 18 ref.

Descriptors: *Hazardous waste disposal, *Industrial wastes, *Lime, *Sludge utilization, *Soil stabilization, *Waste disposal, Hydration, Incineration, Loam, Portland cements, Soil moisture, Waste management.

In recent years, researchers from various fields have attempted to solve environmental problems posed by the production of industrial wastes. Incineration is one way to eliminate problems of disposal of sludgy waste materials containing oily and toxic materials. It is of great benefit to soil stabilization if this kind of waste can be converted into a useful material. A study was performed to examine the potential for burning various industrial wastes combined with lime, in certain proportions, to produce a by-product having cementing characteristics similar to ordinary portland cement (OPC). It was found that the percentages of main cementitious compounds in this new cement-like stabilizer are comparable to those of OPC. The by-product also shows promise for use in stabilizing a loam soil containing a high moisture content and organic matter. The addition of ettringite as a strength developer, due to the fixation of at least 34% of hydration water, can be used to stabilize loam soil for subgrade purposes. The quality of this cement-like material can be controlled by strictly checking the chemical compositions, particularly those of the main oxides, using the calculated hydration modulus of 1.78 as a guideline, prior to each mix design. Future plans include studying the effect of variation of the calculated hydration modulus, particularly at values approaching 2.4, which it is believed would significantly improve the stabilized materials strength. (Fish-PTT)
W91-05867

ABILITY OF SORBENT MATERIALS TO ADSORB AND RETAIN ORGANIC LIQUIDS UNDER LANDFILL CONDITIONS.
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 5B.
W91-05921

5F. Water Treatment and Quality Alteration

CHLORINATION OF HUMIC MATERIALS: BYPRODUCT FORMATION AND CHEMICAL INTERPRETATIONS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
D. A. Reckhow, P. C. Singer, and R. L. Malcolm.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1655-1664, November 1990. 8 fig, 7 tab, 63 ref. EPA Research Grant R-810235.

Descriptors: *Chlorination, *Drinking water, *Fulvic acids, *Humic acids, *Model studies, *Trihalomethanes, *Water treatment, Acetic acid, Chloroform, Statistical models.

Ten aquatic humic and fulvic acids were isolated and studied with respect to their reaction with chlorine. Yields of TOX, chloroform, trichloracetic acid, dichloroacetic acid, dichloroacetonitrile and 1,1,1-trichloropropanone were measured at pH 7 and 12. Humic acids produced higher concentrations than their corresponding fulvic acids of all byproducts except 1,1,1-trichloropropanone. Chlorine consumption and byproduct formation were related to fundamental chemical characteristics of the humic materials. A statistical model was proposed for activated aromatic content based on (13)C NMR and base titration data. The values estimated from this model were found to be well correlated with chlorine consumption. Specific byproduct formation was related to UV absorbance, nitrogen content or the activated aromatic content. (Author's abstract)
W91-04946

STOICHIOMETRY AND KINETICS OF THE REACTION OF NITRITE WITH FREE CHLORINE IN AQUEOUS SOLUTIONS.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-04950

RISK COMMUNICATION IN LOS ANGELES: A CASE STUDY.
Southern California Metropolitan Water District, Los Angeles.
M. G. Shovlin, and S. S. Tanaka.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 40-44, November 1990. 1 tab, 4 ref.

Descriptors: *Communication, *Los Angeles, *Metropolitan water management, *Public relations, *Risk communication, *Risks, *Water treatment, Air stripping, California, Case studies, Public participation, Social aspects.

The communication program of the Los Angeles Department of Water and Power (LADWP) has been largely informational--messages have historically been passed from the utility to the public without citizens being involved in any substantive way in decisions about water quality issues. In 1985, when LADWP made plans to construct an aeration tower to strip contaminants from groundwater without notifying the community in the immediate vicinity of the proposed site, there was a public outcry. The LADWP staff has learned from this and currently is approaching communication and public participation in a more proactive manner. Lessons learned included the importance of public participation in the early planning stages of a project, the advantages of providing as much information as possible to the public and the recognition that risk judgments are often based on fac-

tors other than the degree of hazard. (Author's abstract)
W91-05019

DEVELOPING A RISK COMMUNICATION STRATEGY.
ABB Environmental Services, Inc., Wakefield, MA.
S. L. Santos.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 45-49, November 1990. 8 ref.

Descriptors: *Communication, *Environmental policy, *Public relations, *Risk communication, *Risks, *Water treatment, Decision making, Legislation, Public participation, Regulations, Social aspects, Utilities.

The complex decisions regarding the control of toxic chemicals in drinking water require more than just an understanding of the risks posed and the pollution-control mechanisms that are available. Increasing concern over environmental problems and the passage of more stringent legislation have led utility personnel to recognize that risk communication must become a part of their overall approach to environmental management. The key to effective risk communication is the two-way exchange of information between the utility and the public. The utility explains technical data to interested segments of the public, who in turn voice their concerns, opinions and reactions. The public should also be involved in decisions relating to risk control. (Feder-PTT)
W91-05020

RISK FEEDBACK: AN IMPORTANT STEP IN RISK COMMUNICATION.
Risk Writers Ltd., St. Paul, MN.
S. L. Benjamin, and D. A. Belluck.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 50-55, November 1990. 12 ref.

Descriptors: *Communication, *Environmental policy, *Public participation, *Risk communication, *Risk feedback, *Water treatment, Administrative agencies, Decision making, Environmental quality, Project planning, Risks, Social aspects.

During the past decade, citizens have increasingly demanded that government reduce risks associated with exposure to potentially-toxic chemicals. To better inform the public about environmental risk issues, government agencies are providing increasing amounts of information on the potential risks posed by chemicals discharged into the environment, discovered at a given site, or detected as residues in food. Interactive risk communication requires a strong risk-feedback component. Risk feedback is a structured process whereby the agency solicits, receives and evaluates citizen input for inclusion in a risk-management plan. Procedures for planning and managing risk feedback are presented and applied to a hypothetical drinking-water-contamination situation. Risk feedback guidelines include the following items: (1) Know the goal of each step in the decision-making process and design risk feedback to help achieve that goal; (2) Continually evaluate citizen input against the goals and needs identified in the planning step; (3) Facilitate teamwork; and (4) Select feedback techniques. (Feder-PTT)
W91-05021

EFFECTS OF TEMPERATURE ON TURBULENT FLOCCULATION: FLUID DYNAMICS AND CHEMISTRY.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
A. T. Hanson, and J. L. Cleasby.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 56-73, November 1990. 25 fig, 2 tab, 73 ref. NSF grant ECG-8613737.

Descriptors: *Flocculation, *Hydrodynamics, *Temperature effects, *Turbulent flow, *Water chemistry, *Water treatment, Alum, Analytical techniques, Chemical coagulation, Impellers, Iron compounds, Temperate zone.

Utilities treating surface waters in temperate regions face unique challenges because the water that they treat may be 5 C or colder for five months of the year. An attempt was made to identify the best available measure of the intensity of turbulence with a view to correcting the mixing intensity of the flocculation process to compensate for temperature effects. It was concluded, however, that no one measure of turbulence intensity is better than another. It was observed that the flocculation efficiency at 20 C is not sensitive to impeller geometry, but at 5 C impeller geometry is much more important. A turbine impeller caused much more floc breakup than a stake and stator impeller. With metal coagulants, the use of constant pOH is appropriate for correcting system chemistry for temperature effects. Alum floc was significantly weaker than iron floc under all conditions tested. (Author's abstract)
W91-05022

COLIFORM REGROWTH IN DRINKING WATER: A REVIEW.
American Water Works Service Co., Inc., Belleville, IL. Belleville Lab.
M. W. LeChevallier.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 74-86, November 1990. 4 fig, 166 ref.

Descriptors: *Bacterial analysis, *Bacterial growth, *Coliforms, *Drinking water, *Literature review, *Water quality standards, Biological treatment, Corrosion, Disinfection, Nutrients, Rainfall, Water temperature.

The new 1989 coliform regulations will challenge U.S. water utilities to bring regrowth of bacteria in drinking water systems to a halt. Parameters related to the growth of coliform bacteria in drinking water supplies include environmental factors, such as temperature and rainfall; the availability of nutrients (carbon, nitrogen and phosphorous); the ineffectiveness of disinfectant residuals; corrosion and sediment accumulation; and hydraulic effects. Injured and particle-associated bacteria may not be detected using conventional compliance monitoring procedures, but methods are available to enumerate these organisms and correct treatment deficiencies. Biological treatment, biofilms, assimilable organic carbon and sensitive bacterial enumeration procedures will be utilized in the future. (Feder-PTT)
W91-05023

CONTAMINANTS IN POLYELECTROLYTES USED IN WATER TREATMENT.
American Water Works Association Research Foundation, Denver, CO.
R. D. Letterman, and R. W. Pero.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 11, p 87-97, November 1990. 3 fig, 5 tab, 68 ref.

Descriptors: *Coagulation, *Contamination, *Drinking water, *Polyelectrolytes, *Public health, *Water treatment, Acrylamide, Administrative agencies, Analytical methods, Epichlorohydrin, Polymers, Potable water.

In April 1990, the USEPA transferred the responsibility of offering advisory opinions on the potential health effects of polyelectrolyte coagulant products used in drinking water treatment to a consortium of organizations led by the National Sanitation Foundation. Although more than 1000 polyelectrolyte products were accepted for use by the EPA, evidence suggests that probably fewer than 10 to 15 different types of polymer compounds are represented. Polyelectrolyte products used by the US water supply industry may contain, in addition to the polyelectrolyte, measurable amounts of certain contaminants. These contaminants can be categorized as residual monomers, unreacted chemicals used to form the monomer units, and the products of reactions that transform or degrade residual monomer. The concentration of a residual monomer in a product depends on its manufacturing process. Chronic exposure to low concentrations of contaminants such as acrylamide and epichlorohydrin is an important concern in potable water treatment. Analytical procedures are available for determining contaminant concentrations in polyelectrolyte products. (Feder-PTT)
W91-05024

UTILITY FINANCIAL PLANNING AND RATE DESIGN BY COMPUTER.
Kalamazoo City Dept. of Public Utilities, MI.
For primary bibliographic entry see Field 5D.
W91-05026

APPLICATION OF GAS ABSORPTION THEORIES TO O-CRESOL OZONATION IN WATER.
Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica.
J. L. Sotelo, F. J. Beltran, J. M. Encinar, and M. Gonzalez.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 4, p 341-353, 1990. 4 fig, 3 tab, 17 ref. Comision Asesora de Investigacion Cientifica y Tecnica Grant PA 85/332.

Descriptors: *Cresols, *Kinetics, *Mass transfer, *Organic compounds, *Ozonation, *Ozone, *Water treatment, Absorption, Chemical reactions, Theoretical analysis, o-Cresol.

The reaction rate between ozone and o-cresol in aqueous solution at pH 2 has been studied. According to the absorption theories, the kinetic regime of the process in the experimental conditions investigated corresponds to an irreversible fast pseudo-first order reaction between non-dissociated o-cresol and ozone. Similar values for the rate constant are deduced from different theories: film theory, surface renewal and eddy diffusion theories. Therefore the film theory, having a simple mathematical basis, seems to be the most appropriate model for this kinetic study. The average value of the rate constant deduced from film theory by the differential method was 13,747 M(-1)s(-1). (Author's abstract)
W91-05056

POWER EVALUATION OF THE LOS ANGELES OXYGEN-FED OZONE SYSTEM.
Process Applications, Inc., Fort Collins, CO.
K. L. Rakness, and G. F. Stolarik.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 4, p 355-376, 1990. 4 fig, 6 tab, 7 ref.

Descriptors: *Drinking water, *Economic aspects, *Energy costs, *Ozonation, *Ozone, *Water treatment, *Water treatment facilities, California, Direct filtration, Disinfection, Flocculation, Los Angeles, Oxygen, Performance evaluation, Quality control.

The Los Angeles Department of Water and Power (LADWP) operates a 600 mgd (2,270 ML/day) direct filtration water treatment plant which includes a 7,900 lb/day (149 kg/h) ozonation system. Ozone is applied as a preoxidant for the purposes of disinfection and microflocculation. The ozonation system is unique in that high purity oxygen is generated on-site and is used as the feed gas in a once-through system. The process was selected through competitive bids and evaluated for total present worth from 20-year life cycle costs which included capital plus energy expenses. Power consumption (and penalty) was valued at $6,500/kW. System power demand was measured at nine ozone production rates. A minimum specific energy of 6.5 kWh/lb of ozone was observed when generating ozone at a concentration between 5 and 6% (wt) (65 and 80 g/cu m; where the standard temperature and pressure are 70 F and 1 atm, respectively). The ozonation system, as installed, is believed to represent the most cost-effective process for the Los Angeles Aqueduct Filtration Plant. Power consumption was the dominant criterion use in determing life cycle cost (representing 2/3 of present worth value) and ultimately was the basis for selecting the oxygen/ozone system. (Mackeen-PTT)
W91-05057

METHODS FOR DETERMINING ASSIMILABLE ORGANIC CARBON AND SOME FACTORS AFFECTING THE VAN DER KOOIJ METHOD.

Alberta Univ., Edmonton. Dept. of Civil Engineering.
P. M. Huck, P. M. Fedorak, and W. B. Anderson.

Ozone: Science and Engineering OZSEDS, Vol. 12, No. 4, p 377-392, 1990. 3 fig, 2 tab, 26 ref.

Descriptors: *Analytical methods, *Drinking water, *Laboratory methods, *Organic carbon, *Ozonation, *Water quality, *Water treatment, Assimilable organic carbon, Bacterial growth, Canada, Edmonton, Water quality monitoring.

Methods for measuring the concentration of assimilable organic carbon (AOC) were reviewed and factors affecting the van der Kooij method of AOC determination were investigated. The original AOC method measures the growth of Pseudomonas fluorescens strain P17 in water samples. The Werner method utilizes turbidity measurements to determine the bacterial growth potential of a water sample. The Jago and Stanfield and Cardiff University methods use mixed inocula in an attempt to obtain maximal growth responses. The methods of Billen and Servais and Joret and Levi provide measurements of biodegradable organic carbon. AOC was measured by the van der Kooij method in a pilot plant study in Edmonton, Alberta, Canada. Difficulties with the survival of P. fluorescens strain P17 following sedimentation were attributed to the use of polyaluminum chloride as a coagulant. Ozonation was found to inhibit P17 growth severely. The filtration of samples through cellulose acetate filters increased the measured AOC significantly. (MacKeen-PTT)
W91-05058

OZONE TREATMENT OF SMALL-SIZE SWIMMING POOLS AND WHIRLPOOLS.

Innsbruck Univ. (Austria). Hygiene Inst.
F. H. Tiefenbrunner, H. G. Moll, A. Grohmann, D. Eichelsdorfer, and H. Seidel.

Ozone: Science and Engineering OZSEDS, Vol. 12, No. 4, p 393-400, 1990. 5 fig, 10 ref.

Descriptors: *Disinfection, *Ozonation, *Recreation facilities, *Water treatment, Bacteria, Filtration, Ozone, Swimming pools, Whirlpools.

The use of ozone treatment for the disinfection of small swimming pools and whirlpools was examined. Standard sand filtration practices for small size pools were found to provide inadequate disinfection. At filter bed depths of up to 40 cm, marked amounts of aluminum floccules were observed on sand grains by x-ray fluorescence analysis. Investigations with various indicator strains of bacteria suggested that in order to operate small pools hygienically, Pseudomonas aeruginosa must be eliminated at the filter inlet by disinfection, and flushed out of the filter by effective filter washes. The use of ozone for disinfection of small size pools is recommended due to the superiority of ozone for disinfecting raw water. An ozone high oxidation stage is recommended in disinfecting hot whirlpools, to compensate for the reduced contact time with the disinfectant (chlorine) of small volume systems. Compact, high frequency ozone generators are thought to be suitable for use as regeneration plants for hot whirlpools. (MacKeen-PTT)
W91-05059

RURAL WATER SUPPLY DEVELOPMENT IN FINLAND: POSSIBLE IMPLICATIONS FOR THE DEVELOPING COUNTRIES.

Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
T. Katko, and M. Viitasaari.

Aqua Fennica AQFEDI, Vol. 20, No. 1, p 3-12, 1990. 7 fig, 25 ref.

Descriptors: *Developing countries, *Finland, *Potable water, *Rural areas, *Water resources development, Agriculture, Economic aspects, History, Pumping, Social aspects, Water conveyance, Wells.

Rural water supply is one of the main sectors in Finnish development cooperation. The development of rural water supply in Finland is reviewed with the aim of discussing how this experience might be exploited to solve problems the developing countries are facing today. Finland has developed into a post-industrial nation perhaps faster than any other western country. Consequently, a wealth of knowledge and experience remains on the development of rural water supply systems. Growth in per capita gross national product in Finland over the period 1860 to 1985 was faster in Finland than in Sweden, the United Kingdom, or the United States. Rural water supply has relied primarily on ground water. Wells traditionally were sited by browsing or witching, using a forked willow twig (divining rod). The most common water lifting devices were bucket with rod, handpump, and windlass. Only about 7% of rural households had pumped water in 1950-1951. Public water supplies in cities began to be developed in the 1870s. The first pipe networks were constructed with wooden pipes. A study of women's work hours on farms conducted in 1948 showed that the reason for the relatively primitive state of rural water supply was that women's time was given little value, hence hand carrying of water from wells continued. After World War II, extensive expansion of piped water for animal husbandry needs occurred, and many rural homes received water and sewers, but only after animal sheds were supplied. Piping of water supplies in rural areas followed the introduction of electricity, which was needed to operate the pumps. Clear positive health effects have resulted from the development of organized water systems. Individuals have acted as initiators and managers of water supply systems. The experiences of a country such as Finland suggest that a more realistic time-frame should be used for evaluating efforts at water supply development in developing countries. Several types of technology at different levels, and thus several service standards, should be offered. (Rochester-PTT)
W91-05060

ASSESSMENT OF THE BACTERIOLOGICAL ACTIVITY ASSOCIATED WITH GRANULAR ACTIVATED CARBON TREATMENT OF DRINKING WATER.

Southern California Metropolitan Water District, La Verne. Water Quality Lab.
M. H. Stewart, R. L. Wolfe, and E. G. Means.

Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 12, p 3822-3829, December 1990. 8 fig, 3 tab, 29 ref.

Descriptors: *Bacterial analysis, *Coliforms, *Granular activated carbon, *Heterotrophic bacteria, *Water quality monitoring, *Water treatment, Chloramines, Chlorination, Chlorine, Disinfection, Water treatment facilities.

Bacteriological analyses were performed on the effluent from a conventional water treatment pilot plant in which granular activated carbon (GAC) had been used as the final process to assess the impact of GAC on the microbial quality of the water produced. Samples collected for 160 d from 6 GAC columns were analyzed for heterotrophic plate counts and total coliforms. The results indicated that heterotrophic plate counts in the effluents from all columns increased to 100,000 CFU/ml within 5 days and subsequently stabilized at 10,000 CFU/ml. Coliforms (identified as Enterobacter spp.) were recovered from nondisinfected effluent on only two occasions. Disinfection of the effluents with 1.5 mg/L of chloramines resulted in the inactivation of approximately 50% more bacteria than did disinfection with 1.0 mg/L of free chlorine after 1 h of contact time. Chloramines and chlorine selected for the development of different bacterial species: Pseudomonas spp. and Flavobacterium spp., respectively. Carbon particles were recovered in the effluents at levels of 10-62 particles/L. Scanning electron microscopy indicated that 8% of the particles had no detectable colonized bacteria, 77% were colonized with 1 to 50 bacterial cells, and 8% were colonized with several hundred to several thousand bacterial cells. On one occasion, a fecal coliform identified as Klebsiella pneumoniae was desorbed from a carbon particle. Disinfection studies indicated that bacteria attached to the GAC particles were extremely resistant to either chlorine or chloramines at 1.5 mg/L, even after 40 min of exposure. These findings suggest that chloramines may be more effective than chlorine in controlling the heterotrophic plate counts resulting from GAC treatment when the bacterial population is predominantly composed of non-Pseudomonas spp. It is concluded that bacterially colonized GAC particles released into the product water are extremely resistant to disinfection. (Author's abstract)
W91-05097

MEMBRANE SOFTENING: THE CONCEPT AND ITS APPLICATION TO MUNICIPAL WATER SUPPLY.

Stone and Webster Water Technology Services, Fort Lauderdale, FL.
W. J. Conlon, C. D. Hornburg, B. M. Watson, and C. A. Kiefer.

Desalination DSLNAH, Vol. 78, No. 2, p 157-175, August 1990. 8 fig, 1 tab, 10 ref.

Descriptors: *Florida, *Water treatment, *Reverse osmosis, *Membrane filters, Dissolved solids, Groundwater, *Desalination, Lime, *Water softening, Cost analysis.

A modified reverse osmosis membrane process is being used in Florida instead of lime softening to treat waters with low total dissolved solids (TDS). Membrane softening (MS) is a desalination process since it removes dissolved inorganics as well as organics from the feed water and the product water complies with present SDWA regulations. MS is particularly cost effective in treating ground water in Florida which is high in hardness and natural organics such as humic and fulvic acids. The MS process is similar to conventional reverse osmosis (RO) except three stages are employed for 90% recovery, operation is at 90-120 psi with a booster pump on the third stage; and pretreatment is greatly simplified. Capital costs for MS facilities are less than $0.90 per US gallon/day capacity (over 30 USmgd capacity) and operation and maintenance costs are in the order of $0.40 per 1000 US gallons. Utilizing blending of waters treated by MS and other techniques further enhances the application of MS. Desalination by MS of waters below 1000 ppm TDS extends the economical treatability range of desalination for drinking water supplies. (Author's abstract)
W91-05194

PORTLAND WATER DISTRICT'S WATER DISTRIBUTION MASTER PLAN.

Portland Water District, ME.
J. B. Taylor, and S. L. Bishop.

Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 2, p 123-140, June 1990. 11 fig.

Descriptors: *Maine, Pumping, Water conveyance, *Portland, *Water distribution, *Model studies, *Water requirements, *Water demand, *Future planning, Pressure zones, Pipelines, Water storage, Capital costs.

The Portland, Maine water district has recently completed a water distribution master plan to determine the configuration and sizing of their water transmission and distribution system for the next 25 years. The study required identifying additional towns that might be served and determining what changes would be required in the system to provide a service to these towns. Significant modifications were required to the pressure zones to provide expanded service. Once these modifications were determined, a model of the existing and proposed, transmission distribution system was prepared. Projections of future water supply requirements addressed residential, commercial, and industrial demands as well as potential fire flows. Extensive use of dynamic modeling was made to determine the proper sizing of transmission mains and storage facilities to meet the projected maximum day and peak hour demands. Special design procedures were incorporated in the modeling program to assist in evaluating alternative sizes of pipe

for improvements. As a result of the master plan, it was determined that a major pumping station located at Sebago Lake would provide economical service to meet future demands in conjunction with improvements to the transmission and distribution system. A 5-year capital improvements program was developed by the District as a result of the recommendations provided in the master plan. The District is now in a position to proceed to improve and expand their system in a logical fashion to meet anticipated future demands which may be imposed by growth in the rapidly growing Portland Metropolitan area. (Author's abstract)
W91-05210

WHAT IS A WATER AUDIT.
Easton Water Div., MA.
For primary bibliographic entry see Field 3D.
W91-05211

USE OF CHLORAMINES - PAST, PRESENT AND FUTURE.
Massachusetts Water Resources Authority, Southboro. Water Quality Div.
G. M. Foss.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 2, p 146-148, June 1990. 3 ref.

Descriptors: *Water treatment, *Chemical treatment, *Chloramines, *Disinfection, Colorado, Ottawa, Ammonia, Chlorine, Cost analysis, *Chlorination.

Chloramines in the water treatment process were first used around 1915 when Sir Alexander Houston recognized the superior advantages of chloramines in some treatment processes and suggested applying ammonia prior to chlorine to avoid unpleasant tastes resulting from the chlorination of organic material. In 1916, chloramines were adopted on a plant-scale basis at Denver, Colorado and in 1917 at Ottawa. Widespread use of chloramines followed due to the realization that a more stable residual was produced and that objectionable tastes formed during the disinfection process were reduced. Popularity later declined due to the superior disinfection capability of free chlorine. Present and future EPA rule-making is going to have a large impact on water utilities, both large and small. Design of facilities to achieve compliance with these regulations, should not focus on one regulation or be directed towards one particular treatment process. Each utility should study its own system and then attempt to obtain data through bench-testing, pilot testing or other means to evaluate alternatives that will be both cost-effective, flexible, and able to be operated at the optimum efficiency. Secondary disinfection with chloramines is one such alternative that may be both cost effective and provide the ease of operation necessary to many utilities. (Medina-PTT)
W91-05212

TRANSLATING RESEARCH INTO PRACTICE: THE DRINKING WATER INDUSTRY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-218770. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/014, 1989. 23 p, 9 fig, 2 tab, 10 ref.

Descriptors: *Drinking water, *Research priorities, *Regulations, Water supply, Costs, Decision making, Management planning.

The water supply industry which has traditionally been highly conservative is being forced into rapid and major change by a massive increase in regulatory activity. The industry is currently involved in a regulatory development phase but soon will be forced into a massive implementation effort. Although many innovations are being considered for solving some of these problems, there is relatively little diffusion of new technology into the field. The industry consists of over 200,000 water suppliers most of which are small. Economies of scale dictate that any technological solution adopted will have a high unit cost. In addition, the various groups involved in the decision making process are highly conservative. EPA has a vital interest in information diffusion because it in effect creates the market by writing regulations and then forcing compliance. Although many efforts both in and outside of the EPA have been initiated to accomplish this, these efforts do not seem effective. The theory of information diffusion emphasizes several basic steps that involve making the application of technologies explicit. One mechanism that might assist in this information development process is the development of a Drinking Water Innovative Technology Evaluation program. (Lantz-PTT)
W91-05279

ICA SYMPOSIUM ON INSTRUMENTATION, CONTROL AND AUTOMATION IN WATER AND WASTEWATER MANAGEMENT.
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W91-05281

CONTROL OF THE PUMPED WATER SUPPLY TO WIGGINS WATERWORKS.
Umgeni Water Board, Pietermaritzburg (South Africa).
G. D. Ward.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 29-31.

Descriptors: *Flow control, Control systems, Gravity flow, Balancing reservoirs, *Reservoirs, *Reservoir operation, *Pumps, *South Africa, Valves, Water level, Water supply, Automation.

The Umgeni Water Board's Wiggins waterworks in South Africa was designed to receive water by gravity from the new Inanda Dam on the Umgeni River, with downstream control by means of valves at Wiggins. It was necessary to control the pumps automatically to maintain a reasonably constant level in the balancing reservoir, regardless of the flow demand at Wiggins. The project constraints led to a choice of three large and three small pumps, which in various combinations are equivalent to 15 small pumps. Two primary float switches, separated by 700 mm depth, were provided. A water level below the lower switch prompts a programmable controller to start pumps at regular intervals, initially set at 4 minutes. A water level between the two switches retains the status quo, and a level above the upper switch switches off pumps at the same time interval. Once the flow has stabilized, the routine is identical to the classic pump control method. A number of pumps will provide a base flow, and only one pump will switch on and off, as controlled by the two switches. The controller has performed well; however, the relentless switching on and off of the machinery has taken its toll on the mechanical equipment. An investigation of the pump, motor and transformer characteristics as installed revealed that start-up could be directed into the rising main and the valves were subsequently left open. This has improved operation and made the sequencing logic simpler, as the opening and closing time of the valves need not be taken into account. (See also W91-05281) (White-Reimer-PTT)
W91-05284

AUTOMATION OF THE WATER SUPPLY SCHEME ON THE OFS GOLDFIELDS.
Gold Fields Water Board, Bothaville (South Africa).
A. J. Dippenaar.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 32-39, 3 fig.

Descriptors: *South Africa, *Instrumentation, *Water treatment facilities, *Water supply, *Upgrading, *Automation, Computers, Pumps, Valves, Remote control, Economic aspects, Water use.

The Board for the town of Bothaville, South Africa, operates two water purification plants, but expansion of the facilities was required due to water extraction limitations on the Sand River. In addition to the expansion the Board also renovated the existing facilities. Due to the difficulty in obtaining personnel and providing housing and supervision in the outlying areas an automated system was approved. Balkfontein is the major control center which issues all operating directives, and all other plants and out-stations report to Balkfontein by means of a UHF radio link. Input into and output from the programmable logic controllers is achieved by simple push button panels in the case of pump stations, and personal computers equipped with the appropriate software for the more complex applications like chemical dosing. The system was designed to be maintained on a first line basis, no major repairs to equipment will be done on site. A major problem that developed was that individual plant items, like valves, were tampered with which led to the malfunction of software. Therefore, the plant items were locked and the supervisor was made responsible for the key. As a result of the automation only 4 white and 20 black operators are now needed where previously 50 white and 150 black operators had been required. The use of automation and remote control are greatly assisting the more efficient use of water in South Africa. (See also W91-05281) (White-Reimer-PTT)
W91-05285

INSTRUMENTATION, CONTROL AND AUTOMATION IN WATER AND WASTEWATER MANAGEMENT ELANDSJAGT WATER TREATMENT WORKS.
Ninham Shand, Inc., Cape Town (South Africa).
I. K. Reid.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 40-45.

Descriptors: *Control systems, Flow meters, Reservoirs, Pumps, *South Africa, *Automation, *Instrumentation, *Water treatment facilities, *Wastewater treatment, Computers, Safety, Control panels.

During the design of the Elandsjagt water treatment works in South Africa it was recognized that a centralized computer based system for the management and control of the water supply system as a whole was required. The first stage of the system covers the reservoirs and pump stations up to 15 km from the City center while the operation and control of the major treatment works and the more distant reservoirs and booster pump station continues as before. The system consists of a central control station within the treatment works which contains a control panel with buttons for operating equipment and a mimic diagram of the treatment works showing all units and equipment and displaying trip, run and alarm indication as well as digital display of process parameters and flow. An IBM personal computer is provided for data storage and manipulation. The central panel controls the mechanical plant, flows, process parameters, and water levels. In the event of any of the alarms or trip being activated an alarm light is lit in the central control panel and the operator is able to take appropriate action and dispatch staff to correct the problem. The control system apart from the personal computer has been in operation since the commissioning of the plant in August 1985. Apart from problems experienced with the accuracy of flow meters the equipment has performed well. (See also W91-05281) (White-Reimer-PTT)
W91-05286

USE OF A DIGITAL CONTROL SYSTEM FOR WATER TREATMENT AND MANAGEMENT AT SAPPI'S ENSTRA MILL.

Sappi Fine Papers (Pty) Ltd., Isando (South Africa).
For primary bibliographic entry see Field 5D.
W91-05298

CONDUCTIVITY AS A MEANS OF CONTROL ON THE DEMINERALISATION PLANT AT MATIMBA POWER STATION.
Electricity Supply Commission, Johannesburg (South Africa). Engineering Investigations Div.
E. Maughan.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 96-99.

Descriptors: *South Africa, *Conductivity, *Demineralization, *Powerplants, *Instrumentation, Pumps, Monitoring, Ammonia, Hydrogen ion concentration, Water treatment, *Process control, Cooling water.

The Marimba power station in South Africa is direct-cooled and requires a demineralization plant for the steam-water circuit. The demineralization plant comprises three demineralization trains, each of which consists of a stratified cation exchanger, a degasser, a stratified anion exchanger and a mixed-bed unit. The quality of the water leaving each stage of the demineralization train is monitored for conductivity, sodium, and silica. Once the water leaving a demineralization train fails to meet specifications the resin must be regenerated. The conductivity of the regenerant is measured on-line and the strength is maintained at the desired pre-set value via a signal from a controller in the loop which finely adjusts the metering pump stroke. The dilution water for regeneration is drawn from the demineralized water storage tanks. The quality of this water is also monitored by conductivity measurement. The water treatment plant is monitored and controlled from a control desk with automatic sequences following initiation by the plant operator. Besides analogue and digital displays, plant schematics and operating records may be called onto visual display units, and a hardcopy is also possible. A relationship exists between pH, concentration of ammonia and conductivity, and conductivity is used for control. Monitoring is carried out continuously, and when the measured value varies from the selected setpoint, typically 2.5 to 4.5 microS/cm at 25 C, a signal in the control loop adjusts the variable-stroke pump used for ammonia dosing. (See also W91-05281) (White-Reimer-PTT)
W91-05299

MOLECULAR SIZE DISTRIBUTIONS OF DISSOLVED ORGANIC MATTER.
Arizona Univ., Tucson. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05320

ON-LINE DETERMINATION OF RESIDUAL ALUMINIUM IN POTABLE AND TREATED WATERS BY FLOW-INJECTION ANALYSIS.
Hull Univ. (England). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W91-05330

REDUCING DRINKING WATER SODIUM CONCENTRATIONS DID NOT INFLUENCE ADOLESCENT BLOOD PRESSURE.
Massachusetts Univ., Amherst. Div. of Public Health.
R. W. Tuthill, and E. J. Calabrese.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 7, p 711-729, October 1989. 4 fig, 5 tab, 12 ref. American Waterworks Foundation Contract No. H-82; Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control Contract No. 85-15.

Descriptors: *Blood pressure, *Drinking water, *Human population, *Massachusetts, *Public health, *Sodium chloride, *Water treatment, Diets, Human physiology, Hydrogen ion concentration, Salinity, Sodium, Water chemistry, Water treatment facilities.

Previous investigations established that elementary and high school students residing in Reading, Massachusetts displayed significantly higher blood pressure than their counterparts in the adjacent community of Stoneham, Massachusetts. Extensive evaluations of family history, dietary patterns, socio-demographic variables and chemical measurements of drinking water revealed that the level of sodium in the drinking water was the variable most strongly associated with the higher blood pressure of the Reading students. A subsequent study indicated that female but not male students displayed a significant decrease in their blood pressure when given Stoneham water for all drinking and cooking purposes. Subsequently, the Town of Reading announced its intention to reduce sodium levels in the drinking water by switching from the use of sodium hydroxide to calcium hydroxide as a pH adjustment technique. The impact of such a reduction in drinking water sodium levels (i.e. 120 mg/L to 35 mg/L) on the blood pressure distribution was assessed in Reading school children. The study design included a comparison of the blood pressure values of Reading and Stoneham eighth grade students taken just prior to the proposed change in the drinking water to their blood pressure values one year after the new treatment facility was operational. Because of unanticipated and prolonged problems in the construction and initial operation of the plant, the blood pressure retesting occurred two and a half years after the initial blood pressure screening, and ten months after the Reading treatment plant had been operating with consistently lowered levels of sodium (35 mg/L). Results showed that the reduction in sodium concentration in the Reading drinking water was not associated with a differential change in blood pressure in the Reading adolescents as compared to the Stoneham adolescents. (Author's abstract)
W91-05461

FLY-ASH FOR THE TREATMENT OF WATER ENRICHED IN LEAD(II).
Banaras Hindu Univ., Varanasi (India). Inst. of Tech.
K. P. Yadava, B. S. Tyagi, and V. N. Singh.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 7, p 783-808, October 1989. 17 fig, 5 tab, 33 ref.

Descriptors: *Adsorption kinetics, *Diffusion, *Fly ash, *Lead, *Mass transfer, *Mathematical models, *Model studies, *Wastewater treatment, *Water treatment, Activation energy, Hydrogen ion concentration, Parameter estimation, Temperature effects, Thermodynamics.

The removal of lead(II) is dependent on contact time, concentration, pH and temperature of the solution. The various rate parameters of adsorption were determined at different concentrations and temperatures for the present lead removal system. An empirical model was tested to calculate the kinetics of lead(II) removal at different concentrations. Pore diffusion was the main rate control step. The Langmuir isotherm was applied to quantify the adsorption parameters involved in the present adsorption process, and the isosteric heat of adsorption was calculated at different surface coverages of the adsorbent. The negative value of enthalpy change (-7.269 Kcal/mol) suggests that the adsorption process is exothermic. The activation energy was -8.533 Kjoules. Various calculated thermodynamic parameters helped determine mechanisms involved in the adsorption process. By adjusting the temperature, pH of the solution, and dose of the adsorbent, the lead(II) concentration in water and wastewaters can be reduced below the permissible limit, even to zero concentration. These results may help in the design and establishment of continuous treatment plants for the removal of lead(II) enriched effluents. (Brunone-PTT)
W91-05463

EFFECT OF HIGH SALT CONCENTRATIONS ON OZONE DECOMPOSITION IN WATER.
Universidad Complutense de Madrid (Spain). Dept. de Ingenieria Quimica.
J. L. Sotelo, F. J. Beltran, M. Gonzalez, and J. Dominguez.
Journal of Environmental Science and Health (A) JESEDU, Vol. 24, No. 7, p 823-842, October 1989. 4 fig, 1 tab, 18 ref. Comision Asesora de Investigation Cientifica y Tecnica Grant PA 85/332.

Descriptors: *Decomposition, *Ozone, *Salinity, *Water chemistry, *Water treatment, Carbonates, Hydrogen ion concentration, Kinetics, Phosphates, Phosphoric acid, Sulfates.

Ozone decomposition in water in the presence of different salts varies depending on the nature of the salt and the pH. At low pH, molecular phosphoric acid has a positive influence on ozone conversion. At neutral and basic pH, ozone decomposes through a radical mechanism, whose termination step depends on the type of ionic species present. At pH 6 in the absence of salts or in the presence of chloride ions, the decomposition is considered a second-order termination step. When sulfate, phosphate, or carbonate ions are present in the water, the termination step changes to first order, due to the hydroxyl radical scavenging effect of these ions. These ions destabilize molecular ozone in water. (Author's abstract)
W91-05465

APPLICATION OF COARSE-MEDIA SLOW SAND FILTRATION IN AQUACULTURE.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran, V. L. Casiano, and C. Polprasert.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1817-1824, 1991. 10 fig, 4 ref.

Descriptors: *Aquaculture, *Filtration, *Sand filters, *Wastewater treatment, *Water reuse, *Water treatment, Biological filters, Comparison studies, Fish farming, Nitrogen, Organic carbon, Phosphorus, Turbidity, Water quality.

Aquaculture has been practiced in Asia for a long time and it partially provides the animal protein in diets. The selection of a proper type of water system for any proposed aquaculture facility is a critical factor in the optimization of production and proper utilization of the available land and water supply. A major constraint in aquaculture is a supply of water of suitable quality and quantity. Methods of conserving and reusing the water within the recycled systems are of considerable interest. Coarse-media slow sand filtration was tested as a potentially economical treatment unit in a recirculating aquaculture system. Laboratory experiments were carried out with a pilot-scale experimental unit of a coarse media slow sand filter. A 2.7 m high filter column with a diameter of 0.56 m was operated with a filter media size of 1-2 mm, media depth of 1.0 m, and filtration rates of 0.5 and 0.2 cu m/sq m/hr. This filter was connected to a circular concrete fish tank with a diameter of 1.16 m. The performance of the coarse-media slow sand filter was compared with the 1.5 m by 1.0 m by 1.0 m biological filter operated at a filtration rate of 1.92 cu m/sq m/hr, which was connected to eight fish tanks. Experimental results showed that coarse-media slow sand filtration had a comparatively higher removal efficiency than the biological filter for turbidity, total phosphorous, nitrogen and organic carbon. (Mertz-PTT)
W91-05509

REAGENTLESS-CONTINUOUS FLOW METHOD FOR DETERMINATION OF AQUEOUS OZONE WITH THIN FILM SEMICONDUCTOR AND APPLICATION TO AN ADVANCED WATER TREATMENT PLANT.
Osaka Prefectural Univ., Sakai (Japan). Lab. of Environmental Chemistry.
T. Aoki, H. Oguro, K. Fujiyoshi, and M. Yamamoto.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1961-1968, 1991. 4 fig, 1 tab, 15 ref.

Descriptors: *Analytical techniques, *Disinfection, *Drinking water, *Ozonation, *Ozone, *Water

treatment, Japan, Performance evaluation, Semiconductors, Separation techniques, Thin films, Water analysis.

A method without any reagent for the determination of ultra-trace aqueous ozone, utilizing a glass tube-separation process and a thin film semiconductor was examined. The glass tube was used to transfer ozone from water into a gas phase. Ozone was transferred into clean air flowing in the tube and then was continuously monitored at the thin film semiconductor. Signals were proportional to concentration of aqueous ozone more than 5 microgram/L. The relative standard deviation was 3.8% at 7.6 microgram/L. The interference from hydrogen peroxide, monochloramine, and dichloramine, was completely eliminated. Since October 1988, the monitor has been applied to the advanced pilot-plant in the Murano water treatment plant operated by the Waterworks Department of Osaka Prefecture, Japan. The raw water is pumped from the River Yodo. Two treatment lines operate in parallel. The water supply rate at each line is 45 cubic m/hour. Aluminum sulfate is fed at a dose of about 30 mg/L and chlorine is fed at 0.5 mg/L. Studies on the site variations of the measured aqueous ozone using the monitor are now being carried out in detail. (Mertz-PTT)
W91-05524

WATER QUALITY FOR POTABLE REUSE.
Denver Water Dept., CO.
For primary bibliographic entry see Field 5D.
W91-05547

OPTIMIZATION OF DRINKING WATER CHLORINATION PRACTICES FOR MINIMIZATION OF TRIHALOMETHANES FORMATION.
Puerto Rico Univ., Mayaguez. Dept. of Chemical Engineering.
C. N. Burgos, J. Benitez, and L. Saliceti.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 505-514, 1 fig, 6 tab, 11 ref.

Descriptors: *Chlorination, *Drinking water, *Puerto Rico, *Trihalomethanes, *Tropical hydrology, *Water quality control, *Water treatment, Bromine, Chlorine, Filtration, Hydrogen ion concentration, Model studies, Organic carbon, Organic compounds, Regression analysis.

Operational variables involved in the chlorination of drinking waters which influence the formation of THMs, are identified using raw waters from different geographical areas of Puerto Rico. They were found to be: non-volatile total organic carbon (NVTOC), pH, the ratio of applied chlorine dose to NVTOC, and bromide ion concentration. A factorial experiment was carefully designed with the purpose of ascertaining the effect of those variables on total trihalomethanes (TTHMs) formed during the chlorination process. Pilot plant water filtration and chlorination facilities were designed and built in order to implement the multivariate analysis of the process. A highly significant regression model was developed relating TTHMs formation to the operational variables of the chlorination process. Residual chlorine, a measure of disinfection effectiveness, was also measured and correlated to the same variables. The two correlations developed provide a useful tool for minimization of THMs formation while guaranteeing proper disinfection. (See also W91-05611) (Lantz-PTT)
W91-05662

REMOVAL OF GIARDIA SPP. BY CONVENTIONAL WATER AND SEWAGE TREATMENT PROCESSES AND PRESENCE OF CYSTS IN SURFACE WATERS OF PUERTO RICO.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
For primary bibliographic entry see Field 5D.
W91-05665

WATER QUALITY PROBLEMS OF RURAL COMMUNITIES IN PUERTO RICO--A CASE STUDY.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
R. A. Roman-Seda, I. Pagan Trinidad, R. Williams, S. Shaw, and J. Martinez.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 553-566, 77 fig, 3 tab, 16 ref.

Descriptors: *Developing countries, *Puerto Rico, *Rural areas, *Tropical hydrology, *Water quality, *Water supply, *Water treatment facilities, Case studies, Drinking water, Fecal coliforms, Filtration, Hydraulic design, Sand filters, Training.

Many privately owned rural water supply systems in Puerto Rico have been observed to distribute fecally contaminated waters to their users. Concern over the potential public health hazard this represents has moved the US EPA to sponsor a demonstration project in which appropriate technology is used to correct this condition at a chosen site with a record of chronic fecal contamination. The chosen technology has been slow sand filters (SSF) preceded by horizontal flow gravel prefilters (HFGP). The expectation is that this type of treatment, as witnessed in other Third World countries, will provide bacteriologically safe, potable water at all times, even during the frequent flood events that plague surface waters during the rainy season. An initial water quality characterization has been made of the source. The treatment system is expected to enter the construction phase within the next few months. After construction, a startup and training phase will follow operators of the system. Upon completion of this phase, the system shall be passed on to the community for permanent use. A new intake and dam have been designed in order to take into account the new hydraulic requirements of the proposed system. (See also W91-05611) (Lantz-PTT)
W91-05667

POINT-OF-USE/ENTRY TREATMENT OF DRINKING WATER.
Pollution Technology Review N. 188, 21 pollutionNoyes Publications, Park Ridge, New Jersey. 1990. 146p.

Descriptors: *Administrative regulations, *Drinking water, *Water quality, *Water treatment, *Water treatment facilities, Administrative agencies, Point-of-entry water treatment, Point-of-use water treatment, Water analysis, Water quality monitoring, Water quality standards.

Information is presented on the appliction of point-of-use (POU) and point-of-entry (POE) systems for treating drinking water, based on the papers presented at a recent conference held in Cincinnati, Ohio. Papers covered both administrative and technical aspects of utilizing POU/POE systems to solve individual and small community drinking water problems. Until Recent years, the principal use for POU systems was to improve the the aesthetic quality (taste and odor) of drinking water provided by a municipal or private water supply. With the passage of the Safe drinking Water Act and a greater concern by the public on health issues, consumers have begun to purchase these systems for health reasons as well as aethetic reasons. With this increase in the use of POU systems for health reasons, many issues have been raised by the regulatory agencies and water utility industry over the role of POU/POE systems in solving drinking water problems. (See W91-05695 thru W91-05719) (Mackeen-PTT)
W91-05694

POINT-OF-ENTRY AND POINT-OF-USE DEVICES FOR MEETING DRINKING WATER STANDARDS.
Environmental Protection Agency, Washington, DC.
S. W. Clark.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 4-9. 2 ref.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Regulations, *Safe Drinking Water Act, *Water quality standards, *Water treatment, Administrative agencies, Administrative regulations, Bottled water, Compliance, Environmental Protection Agency, Legislation, Water quality.

The Safe Drinking Water Act Amendments of 1986 require the EPA to set standards for 83 contaminants by June of 1989. Recognizing the difficulty that small drinking water supply systems would have complying with many of the new standards, EPA considered allowing a variety of decentralized approaches, including point-of-entry (POE) devices, point-of-use (POU) devices, and bottled water. Three options were discussed at a public hearing on decentralized approaches to drinking water treatment: (1) consider POE to be an acceptable means of compliance; (2) allow POE. POU, and bottled water as acceptable means of compliance; and (3) consider POE, POU, and bottled water to be best available technology (BAT) for small systems (less than 500 persons). After considering all public comments and through a variety of discussions at all levels of management, EPA decided that POE devices were suitable for compliance, but they were not BAT. It was also decided that POU and bottled water could be used as interim measures, but were not to be considered BAT or a means of compliance. Five criteria are necessary for compliance using POE: central control, effective monitoring, application of effective technology, maintenance of microbial safety, and protection of all consumers. It was concluded that the approach using POE devices may allow a cost effective means of compliance for small systems that have had the most violations of EPA's drinking water standards. (See also W91-05694) (MacKeen-PTT)
W91-05695

REGULATORY REQUIREMENTS FOR POINT-OF-USE SYSTEMS.
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
R. Douglas.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 10-11. 1 ref.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Regulations, *Water quality, *Water quality standards, *Water treatment, Administrative agencies, Administrative regulations, Compliance, Filters, Legislation.

There are three general categories of water treatment units: (1) units not intended to treat microorganisms or other pests; (2) units that consist of only a physical or mechanical means of treating any microorganisms or pests; and (3) units that incorporate a chemical antimicrobial agent to treat microorganisms or pests. Products in the first category are subject to neither registration nor regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Products in the second category are only subject to regulation under FIFRA. Products in the third category are subject to both registration requirements and regulation under FIFRA. The requirements for registration of bacteriostatic water filters have not changed since 1979, and consist of data showing effectiveness of the product against bacteria, viruses, and protozoan cysts. Specific testing parameters for products claiming effectiveness as microbiological water purifiers have been published in the 'Guide Standard and Protocol for Testing Microbiological Water Purifiers', dated April 1986 and revised in April 1987. (See also W91-05694) (MacKeen-PTT)
W91-05696

CONTROL OF POINT-OF-USE WATER TREATMENT DEVICES IN CANADA: LEGAL AND PRACTICAL CONSIDERATIONS.

Environmental Health Directorate, Ottawa (Ontario).
R. S. Tobin.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 12-14. 9 ref.

Descriptors: *Canada, *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Regulations, *Water quality, *Water treatment, Administrative agencies, Administrative regulations, Legal aspects, Legislation, Water quality standards.

In Canada there is no specific legislation controlling the sale, use, or performance of point-of-use (POU) water treatment devices. A number of acts, however, do have provisions that could be related to these devices. The Pest Control Products Act may be applied to devices (e.g. ozonators, chemical feeders) that are used for the treatment of nonpotable water. Depending upon the exact claims made, POU devices may come under the provisions of The Medical Devices Regulations. The Hazardous Products Act may be applied to consumer products which may represent a danger to the health and safety of the public. Parts of the Competition Act have been used where misrepresentation of devices has been alleged. The Health and Welfare Canada program on POU devices includes the following nonlegislative aspects: testing and evaluation of devices; provision of advice and educational materials; and cooperation with industry and nonprofit organizations. (See also W91-05694) (MacKeen-PTT)
W91-05697

REGULATION OF WATER TREATMENT DEVICES IN CALIFORNIA.
R. F. Burns.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 15-17. 4 ref.

Descriptors: *California, *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Regulations, *Water quality, *Water treatment, Administrative agencies, Administrative regulations, Legal aspects, Legislation, Water quality standards.

During 1986, the California legislature enacted two legislative measures regarding point-of-use (POU) and point-of-entry (POE) water treatment devices. Senate Bill SB 2119 enacted a statute which requires that any water treatment device for which a health benefit claim is made cannot be sold in California unless the device had performance testing that had been certified by the Department of Health Services (DHS). The law further requires the DHS to adopt regulations setting forth the criteria and procedures for certification of the devices. The DHS Public Water Supply Branch has been given the responsibility for the implementation of SB 2119 and is currently developing policy and regulations for the certification program. Senate Bill SB 2361 enacted a statute which provides 'truth-in-advertising' as it relates to water treatment devices. The statute addresses false or misleading advertising and is expected to deter unscrupulous salespersons and reduce the number of complaints relative to fraudulent sales. (See also W91-05694) (MacKeen-PTT)
W91-05698

WISCONSIN REGULATION OF POINT-OF-USE AND POINT-OF-ENTRY WATER TREATMENT DEVICES.
Wisconsin Dept. of Industry, Labor and Human Relations, Madison.
L. Trapp.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 18-21. 3 append.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Water quality, *Water treatment, *Wisconsin, Administrative agencies, Administrative regulations, Legal aspects, Legislation, Public health, Water quality standards.

Wisconsin's involvement in regulating point-of-use (POU) and point-of-entry (POE) water treatment devices involves five different state agencies. Two of those state agencies, the Department of Justice and the Department of Agriculture, Trade and Consumer Protection, have consumer protection sections. A third state agency, the Department of Health and Social Services, is responsible for recommending enforcement standards for groundwater contaminants of public health concern. The Department of Natural Resources (DNR) uses the enforcement standards to establish whether or not a water supply is contaminated. The Department of Industry, Labor and Human Relations (DILHR) reviews all POU and POE water treatment devices for safety and performance. Water treatment device manufacturers and dealers will most often become involved with DILHR regulations, and to a lesser extent DNR regulations. A list of contact people for each of the five state agencies is provided. (See also W91-05694) (MacKeen-PTT)
W91-05699

HOUSEHOLD WATER QUALITY EDUCATION: THE COOPERATIVE EXTENSION SYSTEM ROLE.
Kansas State Univ., Manhattan. Cooperative Extension Service.
G. M. Powell.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 22-24. 4 tab.

Descriptors: *Drinking water, *Education, *Kansas, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water quality monitoring, *Water treatment, Administrative agencies, Compliance, Legislation, Safe Drinking Water Act, Water quality standards, Well water.

An educational program on household water quality is conducted by the Kansas Cooperative Extension Service. The extension system is a complex organization of the 50 state Cooperative Extension Services and the Extension Service, U.S. Dept. of Agriculture (USDA). Private water wells, which serve 20% of the Kansas population, exceeded the maximum contaminant level for inorganics in 37% of wells tested, and 10% of the wells contained organic contaminants. It was estimated that at least half of the state's private water supplies would not meet standards established by the Safe Drinking Water Act and its amendments. The Kansas Cooperative Extension Service program provides information on quality of water from private wells and in all homes. It includes training of county agricultural, home economics, 4-H and youth agents, and county health services personnel as local sources of information. Bulletins and leaflets address water quality, water testing, water treatment, and water quality protection. (See also W91-05694) (MacKeen-PTT)
W91-05700

FEDERAL TRADE COMMISSION REGULATION OF WATER TREATMENT DEVICES.
Federal Trade Commission, Washington, DC.
J. Winston.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 25-26.

Descriptors: *Administrative agencies, *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water treatment, Administrative regulations, Consumer protection, Federal Trade Commission, Legal aspects, Legislation.

The Federal Trade Commission (FTC) is a small independent Federal Agency with a broad mandate: to promote free and open competition and protect consumers from unfair and deceptive practices. The FTC has no specific regulations governing the advertising of water treatment devices. Like other advertising, claims for these devices must be truthful and substantiated. In general, the types of advertising claims that the FTC may be concerned about in this area are as follows: claims that a device will purify the water or remove all contaminants; claims that ordinary tap water is hazardous to health; and false claims of consumer or expert endorsements. In 1987, two formal actions were brought against advertisers of water treatment devices. New Medical Techniques, Inc. was charged with false advertising of its Aquaspring Home Water Distiller after claiming that the device would remove all contaminants from water. An administrative complaint was issued against North American Philips Corporation, maker of the Norelco Clean Water Machine, a table-top activated carbon filter. In addition to these cases, the FTC continues to monitor advertising that concerns water treatment issues. (See also W91-05694) (MacKeen-PTT)
W91-05701

POU/POE PRODUCT PROMOTION GUIDELINES AND CODE OF ETHICS.
Water Quality Association, Lisle, IL.
M. M. Robb.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 27-30. 2 fig.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Regulations, *Water quality, *Water treatment, Consumer protection, Organizations, Public health, Standards, Water quality standards.

The Water Quality Association (WQA), an industry-sponsored organization, has advanced a set of voluntary guidelines and code of ethics for the promotion of point-of-use (POU) and point-of-entry (POE) water treatment devices. The guidelines were adopted in March of 1985 and revised in April of 1987. Two types of requests can be submitted through the Voluntary Industry Product Promotion Guidelines process. They are a Complaint Request, filed on an existing advertisement or promotion, which can be voluntarily resolved or can move on to the Review Panel; and an Advisory Request, in which a company submits its promotional material or advertising for compliance prior to printing or releasing it. A trend toward voluntary compliance with the guidelines has been observed. A Voluntary Industry Code of Ethics was expected to be published by the WQA in early 1988. (See also W91-05694) (MacKeen-PTT)
W91-05702

NSF'S LISTING PROGRAM FOR POU/POE DWTUS.
National Sanitation Foundation, Ann Arbor, MI.
R. A. Dougherty.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 31-34. 2 tab.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water quality standards, *Water treatment, Consumer protection, Organizations, Standards.

The National Sanitation Foundation (NSF) has established a listing program for point-of-use (POU) and point-of-entry (POE) water treatment devices. NSF standards are voluntary, consensus standards which specify the minimum requirements for a product to satisfy public health concerns. NSF Listing Marks are for use on listed products which fully comply with all NSF requirements. NSF has legal, contractual, and ethical obligations to monitor and verify that only authorized companies use the mark, and use it properly. Public listings information on drinking water treatment units is made available in a listing book published annually, up to nine supplements published each year, and by direct electronic access by computer. Listing is on an annual basis, with continuous monitoring of listed products. Complaints from public health or other regulatory officials or from users for noncompliance are investigated by NSF. The listing program for POU/POE devices has 13 companies with listed units; 21 additional companies have applied for listing. (See also W91-05694) (MacKeen-PTT)
W91-05703

WATER QUALITY ASSOCIATION VOLUNTARY PRODUCT VALIDATION PROGRAM AND VOLUNTARY CERTIFICATION PROGRAM.
Water Quality Association, Lisle, IL.
L. Cole.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 35-36.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Professional certification, *Regulations, *Water quality, *Water treatment, Consumer protection, Organizations, Professional personnel, Public health, Standards, Water quality standards.

The Water Quality Association (WQA) has developed voluntary programs for product validation and for professional certification in the water quality improvement industry. The product validation program comprises five voluntary industry standards: (1) for household, commercial and portable exchange water softeners; (2) for efficiency-rated water softeners; (3) for household and commercial water filters; (4) for point-of-use low pressure reverse osmosis drinking water systems; and (5) for distillation drinking water systems. Under the program, a manufacturer may voluntarily submit a specific type of equipment or system to the WQA laboratory where its performance will be evaluated in accordance with the appropriate standard. Over 300 products produced by companies in the water quality improvement industry have been validated by the WQA laboratory. The WQA certification program was established by association members to provide industry-wide standards for evaluating the knowledge of point-of-use/point-of-entry water treatment personnel. Since the inception of the program in 1977, nearly 1,800 people have been certified in one of three categories: dealer, specialist, or installer. (See also W91-05694) (MacKeen-PTT)
W91-05704

GUIDE STANDARDS AND PROTOCOL FOR TESTING MICROBIOLOGICAL WATER PURIFIERS.
Army Biomedical Research and Development Lab., Fort Detrick, MD.
S. A. Schaub, and C. P. Gerba.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 37-43. 2 fig, 7 tab.

Descriptors: *Drinking water, *Microorganisms, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Regulations, *Water quality, *Water quality standards, *Water treatment, Consumer protection, Human diseases, Microbiological analysis.

A Guide Standard and Protocol for Testing of Microbiological Water Purifiers was developed by a multidisciplinary task force and has been accepted on a provisional basis by the U.S. EPA's Office of Drinking Water and Office of Pesticide Programs. The test protocol addresses the following technologies: ceramic filtration candles, halogenated resins and units, and ultraviolet (UV) units. The microbiological challenges for testing were selected to be representative of bacterial, viral, and protozoan pathogens of the gastrointestinal tract. Physical and chemical parameters are tested using a worst case challenge of pH, total organic carbon, turbidity, total dissolved solids, temperature and for UV light units, a UV quenching test component. Standards of acceptance for microbiological treatment require that less than 10% of the sample pairs from three units tested fall below the tolerances for removal: 99.999% removal for bacteria; 99.9% removal for virus; and 99.5% removal for protozoa. It is concluded that the Guide Standard and Protocol for Testing Microbiological Water Purifiers provides the water industry, consumers, and government with a common approach to the evaluation of existing and development products for their microbiological removal capabilities. (See also W91-05694) (MacKeen-PTT)
W91-05705

PERFORMANCE AND APPLICATIONS OF GRANULAR ACTIVATED CARBON POINT-OF-USE SYSTEMS.
Amway Corp., Ada, MI. Research and Development Div.
K. Van Dyke, and R. W. Kuennen.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 44-61. 7 fig, 12 tab, 20 ref.

Descriptors: *Drinking water, *Granular activated carbon, *Point-of-entry water treatment, *Point-of-use water treatment, *Volatile organic compounds, *Water quality, *Water treatment, Compliance, Legislation, Literature review, Performance evaluation, Safe Drinking Water Act, Water quality standards.

Laboratory and field tests of point-of-use (POU) water treatment devices based on granular activated carbon (GAC) were summarized. The addition of volatile organic compounds (VOCs) to the Safe Drinking Water Act, with their low maximum contaminant levels (MCL) places more stringent requirements on devices claiming to remove them to below MCL concentrations. There are two basic criteria that determine the efficacy of a GAC-based POU device: the capacity of the GAC used (isotherm capacities) and the design of the final unit to approach maximum capacity (dynamic testing). Results have indicated that a properly designed POU device can be effective in removing the regulated VOCs to below the MCL concentrations for a significant period. Isotherm capacities can predict relative breakthrough orders for the VOCs. Temperature was found to be an important parameter in POU treatment device testing. Testing with a surrogate chemical, e.g. chloroform, provides a conservative capacity value for the other VOCs. (See also W91-05694) (MacKeen-PTT)
W91-05706

PERFORMANCE AND APPLICATION OF RO SYSTEMS.
Desalination Systems, Inc., Escondido, CA.
D. T. Bray.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 62-68. 10 fig.

Descriptors: *Drinking water, *Membrane processes, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Reverse osmosis, *Water quality, *Water treatment, Bacteria, Leakage, Microorganisms, Performance evaluation, Viruses, Water quality standards.

Performance and application of reverse osmosis (RO) systems for point-of-use (POU) water treatment were discussed. The three types of RO systems currently in use, under the counter, over the counter and office units, all use a spiral-wound membrane assembly. Two types of membrane are utilized in RO POU units: cellulose acetate types, which have the advantages of low cost, good ionic rejection and greater experience in use; and thin film membranes, which provide high flow rates, high rejections, operate at a wide range of temperature and pH, and are bacteria resistant. Approximately 500,000 RO POU units are in use in the United States. The economic value in 1987 was about $40 million to the system manufacturers and $100 million to the dealers and distributors. While membranes can be made to be leakage-free with respect to bacteria and viruses, by-pass leakage on the order of 0.1 to 0.5% exists in RO POU systems. For this reason, the RO POU systems are not recommended for use on a nonpotable water supply. (See also W91-05694) (MacKeen-PTT)
W91-05707

PERFORMANCE AND APPLICATION OF ULTRAVIOLET LIGHT SYSTEMS.
Ideal Horizons, Inc., Rutland, VT.
C. Foust.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 69-70.

Descriptors: *Disinfection, *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Ultraviolet radiation, *Water quality, *Water treatment, Bacteria, Microorganisms, Performance evaluation, Public health, Viruses, Water quality standards.

The use of ultraviolet (UV) light systems for the disinfection of water was evaluated. Three parameters important in the treatment of water with UV light are the sensitivity of the organisms, the dosage required, and the unit design. Most pathogenic microorganisms have been tested for their sensitivity to UV light and the results have been published in various publications. Data using wavelengths other than 254 nm should be corrected for effectiveness. Most units treat with a dosage of 30,000-35,000 microW-s/sq cm, which is capable of approximately a four log reduction in microorganisms. In general, UV light treatment systems consist of a cylindrical reaction chamber, a bulb separated by a quartz sleeve, a flow control device and a monitoring and/or shut-off device. Advantages of the method include elimination of the addition of harmful chemicals to the water, with consequent avoidance of secondary chemical products; no taste or odor imparted to the water; no possibility of overtreatment; users are not exposed to any harmful products; and limited maintenance required. (See also W91-05694) (MacKeen-PTT)
W91-05708

PRECOAT CARBON FILTERS AS BARRIERS TO INCIDENTAL MICROBIAL CONTAMINATION.
Everpure, Inc., Westmont, IL.
P. Regunathan, W. H. Beauman, and D. J. Jarog.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 71-80. 15 fig, 9 tab, 14 ref.

Descriptors: *Drinking water, *Microbiological studies, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water treatment, Bacteria, Carbon filters, Coliforms, Enteroviruses, Heterotrophic bacteria, Microorganisms, Performance evaluation, Protozoa, Viruses, Water quality standards.

The use of point-of-use (POU) precoat carbon filters as barriers to microbial contamination of drinking water was analyzed. Results indicated that precoat carbon filters caused significant reductions in the numbers of coliforms (99%), enteric viruses (99%), and protozoan cyst or surrogates (>99.9%). Silver in precoat carbon filters lowered coliform levels at least one log more than the standard precoat filters. Silver and copper were found to act slowly to reduce coliform levels in filters during nonuse periods. A new procedure for determining heterotrophic plate count (HPC) organisms involved incubation for 7 days at 25-28 C, instead of 2 days at 35 C. The new method yielded 0.5-1.5 logs higher counts and favored a different population. Silver appeared to effectively control the filter effluent HPC levels. It was concluded that carbon precoat filters with or without silver act as barriers to incidental microbial contamination of potable water supplies. (See also W91-05694) (MacKeen-PTT)
W91-05709

MICROBIOLOGICAL STUDIES OF GRANULAR ACTIVATED CARBON POINT-OF-USE SYSTEMS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
D. J. Reasoner.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 81-83. 2 ref.

Descriptors: *Activated carbon, *Drinking water, *Microbiological studies, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water treatment, Bacteria, Granular activated carbon, Heterotrophic bacteria, Microorganisms, Performance evaluation, Water quality standards.

The microbiological characteristics of granular activated carbon (GAC) point-of-use (POU) filters

were examined. It was found that heterotrophic plate counts (HPC) of the filtered water were generally higher in morning samples than in afternoon samples. Stagnation periods from several hours to several weeks resulted in significantly increased HPC levels in the test filters. The potential for colonization of filters was examined by innoculating the filters with pure culture suspension. Pseudomonas aeruginosa, Enterobacter aerogenes, and Citrobacter freundii were found to colonize the filters and persisted in the product water for time periods ranging from 5-156 days. Recommendations for use of POU home treatment devices include: use only on a microbiologically safe water supply; flush unit after prolonged quiescent period; change the filter cartridge at least as frequently as directed by the manufacturer; and adhere to the manufacturer's maintenance recommendations. It was concluded that all GAC POU devices become generators of bacteria but the potential for adverse human health effects from ingestion of large numbers of HPC bacteria in water appears to be low. (See also W91-05694) (MacKeen-PTT)
W91-05710

HEALTH STUDIES OF AEROBIC HETEROTROPHIC BACTERIA COLONIZING GRANULAR ACTIVATED CARBON SYSTEMS.
Health Effects Research Lab., Cincinnati, OH. Toxicology and Microbiology Div.
A. P. Dufour.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 84-87. 3 tab, 12 ref.

Descriptors: *Activated carbon, *Drinking water, *Human diseases, *Microbiological studies, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water treatment, Bacteria, Connecticut, Granular activated carbon, Heterotrophic bacteria, Microorganisms, Performance evaluation, Water quality standards.

The health effects of the amplification of aerobic heterotrophic bacteria by granular activated carbon (GAC) filters were examined. The study was conducted at a large military reservation in eastern Connecticut. Health data were collected by health status calendar and by instructing participants to report to the medical facility if they experienced a gastrointestinal illness or skin infection. The exposure to heterotrophic bacteria was, on the average, 20 times greater for bypass-filter users than for control groups. The faucet-type filter effluents contained about 12 times more heterotrophs than were found in tap water. During the course of the study, only a few individuals reported to the medical facility for treatment. No bacterial specimens were obtained from these patients and, therefore, no relationship between clinical isolates and isolates from GAC could be established. No excess illness could be linked to the use of GAC filters when the health status calendars were analyzed. It is concluded that point-of-use GAC treated water containing high densities of heterotrophic bacteria is not a risk factor for healthy populations. (See also W91-05694) (MacKeen-PTT)
W91-05711

ACTIVATED ALUMINA FOR POU/POE REMOVAL OF FLUORIDE AND ARSENIC.
Water Treatment Engineers, Scottsdale, AZ.
R. L. Lake.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 88-89. 8 ref.

Descriptors: *Activated alumina, *Arsenic, *Drinking water, *Fluorides, *Ion exchange, *Point-of-entry water treatment, *Point-of-use water treatment, *Water quality, *Water treatment, Performance evaluation, Resins, Water chemistry, Water quality standards.

The use of activated alumina in point-of-use (POU) and point-of-entry (POE) systems for the removal of fluoride and arsenic was discussed. Activated alumina (AA) is primarily a hydrated aluminum oxide which has been heated to a temperature of 300-700 C. AA should be pre-treated before incorporation into a POU/POE system by back washing and acid washing. Acid-treated AA is primarily an anion exchanger. An effective regeneration method for AA entails allowing complete replacement of the sorbate with hydroxide followed by complete neutralization of the basic state AA with acid. It is concluded that POU systems utilizing activated alumina constitute a cost effective method of treating high fluoride and/or arsenic water in situations where the cost of central treatment would be prohibitive. (See also W91-05694) (MacKeen-PTT)
W91-05712

MODELLING POINT-OF-ENTRY RADON REMOVAL BY GAC.
Maine Univ., Orono.
J. D. Lowry, and S. B. Lowry.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 90-98. 7 fig, 3 tab, 28 ref. U.S. EPA Grant R8108290.

Descriptors: *Drinking water, *Granular activated carbon, *Point-of-entry water treatment, *Point-of-use water treatment, *Radon, *Water quality, *Water treatment, Field tests, Model studies, Performance evaluation, Radioisotopes, Water quality standards.

A design model for the removal of radon by granular activated carbon (GAC) in point-of-entry (POE) applications was developed. A first order model accurately described the adsorption/decay steady state removal of Rn-222 by GAC. A single design constant, Kss, could be used to rank a given GAC type for Rn-222 removal. The ranking of a carbon for steady state performance did not appear to be related to its ranking according to an adsorption isotherm. There was a significant range of design constant for the carbons tested, making the selection of the correct GAC important. This is especially true for small public water supply application, where economics are more sensitive to vessel size. More than 99% reduction of Rn-222 is possible with an effective GAC. The progeny of Rn-222 make it important to consider the location of and protective shielding for a GAC bed, to minimize increased gamma exposure over background levels. Limited data indicated a possible premature fouling of approximately 3-5% of existing GAC units. (See also W91-05694) (MacKeen-PTT)
W91-05713

POINT-OF-ENTRY ACTIVATED CARBON TREATMENT LAKE CARMEL--PUTNAM COUNTY.
New York State Dept. of Health, Albany. Bureau of Public Water Supply Protection.
G. A. Stasko.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 99-105. 2 fig, 8 tab.

Descriptors: *Activated carbon, *Drinking water, *New York, *Point-of-entry water treatment, *Point-of-use water treatment, *Water quality, *Water treatment, Coliforms, Lake Carmel, Performance evaluation, Putnam County, Volatile organic compounds, Water quality standards.

Activated carbon point-of-entry treatment systems were implemented in Lake Carmel, Putnam County, New York. After complaints from residents of petroleum odors in their well water, an investigation revealed that water supplies had been contaminated by localized petroleum leaks and spills, and by chemicals flushed into septic systems. In addition, high nitrate levels and widespread bacterial contamination of the water was discovered. The health department recommended that a public water supply be provided for the affected area, and a feasibility study found that the cost would exceed $1200 per year per homeowner. Therefore, a point-of-entry water treatment system was designed comprising the following: a raw water tap used to collect untreated samples; two 5 micrometer cartridge-type prefilters to remove particulate matter; two activated carbon filters in series; a valving arrangement to allow for water use during the cylinder changing procedure; pressure gages before and after the treatment system to determine head loss across the system; and an ultraviolet light disinfection component located after the activated carbon units. The systems are managed by a not-for-profit corporation formed by the homeowners. The annual charge for system operation is currently $320 per year. Bacteriological analysis of 21 paired samples indicated that three untreated samples had high coliform counts and one treated sample had a count of 2 coliforms/100 ml. Limited testing for organic compounds indicated that the system was performing satisfactorily. (See also W91-05694) (MacKeen-PTT)
W91-05714

COMMUNITY DEMONSTRATION OF POU SYSTEMS REMOVAL OF ARSENIC AND FLUORIDE: SAN YSIDRO, NEW MEXICO.
Leedshill-Herkenhoff, Inc., Albuquerque, NM.
K. Rogers.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 106-110. 1 tab.

Descriptors: *Drinking water, *New Mexico, *Point-of-entry water treatment, *Point-of-use water treatment, *Reverse osmosis, *Water quality, *Water treatment, Arsenic, Coliforms, Fluorides, Performance evaluation, Safe Drinking Water Act, San Ysidro, Water quality standards.

Point-of-use (POU) treatment of drinking water containing elevated arsenic and fluoride levels was discussed for the community of San Ysidro, New Mexico. San Ysidro is a small rural community of approximately 200 people where the mean annual income is $13,500 per family. The local groundwater contains leachate from geothermal activity in the area's abundant mineral deposits and exceeds the standards and/or maximum contaminant levels for arsenic, fluoride, iron, manganese, chloride, and total dissolved solids. After consideration of treatment alternatives, approximately 70 point-of-use reverse osmosis (RO) systems were installed in the homes of the villagers, for treatment of cooking and drinking water. Periodic testing of the units has revealed occasional coliform contamination which is treated by replacement of the RO module and disinfection of the tubing and tank. Preliminary data indicated that some RO membranes need replacement as often as once per year. The most prevalent maintenance problems have been leaks. It is concluded that POU treatment is the best choice for the water system of San Ysidro at the current time. (See also W91-05694) (MacKeen-PTT)
W91-05715

FLORIDA'S FUNDING FOR CONTAMINATION CORRECTION.
Florida State Dept. of Environmental Regulation, Tallahassee.
G. Dykes.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 111-112.

Descriptors: *Drinking water, *Florida, *Granular activated carbon, *Point-of-entry water treatment, *Point-of-use water treatment, *Water quality, *Water treatment, Aldicarb, Compliance, Cost analysis, Ethylene dibromide, Legislation, Performance evaluation, Safe Drinking Water Act, Volatile organic compounds, Water quality standards.

Possible to correct the contamination of Florida's groundwater were evaluated. Testing by the U.S. EPA and by state laboratories confirmed the contamination of groundwater by aldicarb and ethylene dibromide (EDB). Legislative efforts at correcting the contamination included the passage of the Water Quality Assurance Act in 1983, provision of funding to correct the EDB contamination problem, and the establishment of the Inland Protection Trust Fund to address groundwater contamination from leaking underground petroleum

storage tanks. The Groundwater Contamination Task Force was organized to address EDB and other contaminant problems. It found that point-of-entry (POE) carbon filtration was a satisfactory method of removing EDB. Granular activated carbon filtration has also been shown to remove benzene and other hydrocarbons, and thus may be useful in correcting petroleum contamination. Projected cost per household for the POE system was $12,000. In view of the high cost of POE treatment, it is recommended that a central system for the whole community be considered. (See also W91-05694) (MacKeen-PTT)
W91-05716

MONITORING AND MAINTENANCE PROGRAMS FOR POU/POE.
National Sanitation Foundation, Ann Arbor, MI.
G. E. Bellen, and T. G. Stevens.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 113-117. 5 tab, 15 ref.

Descriptors: *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water quality monitoring, *Water treatment, Administrative agencies, Administrative regulations, Compliance, Environmental Protection Agency, Water quality standards.

Providing water to consumers that meets the U.S. EPA National primary Water regulations requires system organization, maintenance, and monitorig. The EPA has specified conditions that must be met for the use of POU/POE systems: central control of the treatment devices; effective monitoring; application of effective technology; maintenance of microbiological safety; and protection of all consumers. POU/POE treatment technologies include reverse osmosis, cation exchange, anion exchange, activated alumina, direct filtration, activated carbon, and distillation. A proposed minimum monitoring program requires contaminant monitoring of at least seven devices per quarter for the first two years and three per quarter after the useful life of the devices has been established. Microbiological sampling required includes routine monitoring of heterotrophic plate counts and coliforms, and testing for fecal coliforms if positive coliform results are obtained. Treated volume recordings should be obtained on 25% of devices per quarter for the first year and 10% per quarter thereafter. Additional source water monitoring is required by the EPA. It is concluded that effective and reasonable monitoring programs can be developed for POU/POE devices to assure that U.S. EPA National Primary Drinking Water Regulations are met by the product water. (See also W91-05694) (MacKeen-PTT)
W91-05717

POINT-OF-USE AND POINT-OF-ENTRY TREATMENT DEVICES USED AT SUPERFUND SITES TO REMEDIATE CONTAMINATED DRINKING WATER.
Environmental Protection Agency, Chicago, IL. Region V.
S. L. Bianchin.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 118-128. 5 fig.

Descriptors: *Drinking water, *Illinois, *Indiana, *Point-of-entry water treatment, *Point-of-use water treatment, *Site remediation, *Superfund, *Water quality, *Water treatment, Administrative agencies, Byron, Elkhart, Environmental Protection Agency, Water quality standards.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), referred to as the Superfund Law, provided broad federal authority and resources to investigate and respond to releases of hazardous substances. Over two-thirds of Superfund actions to date deal with a contaminated drinking water supply. Short-term alternatives to alleviate the danger of contaminated drinking water include bottled water, alternative water, point-of-use (POU) treatment devices, and point-of-entry (POE) treatment devices. A case history of the Byron Johnson Salvage Yard Superfund site, located in Byron, IL is presented. After EPA studies that documented groundwater contamination by volatile organic compounds, POU and POE treatment systems were installed in some areas. A second Superfund site, the Main Street Well Field in Elkhart, IN, was also discussed in detail. At homes where the water exhibited minor trichloroethylene contamination, or where municipal water hookup was not feasible, POU or POE treatment devices were installed. A number of pilot projects using POU/POE treatment devices at Superfund sites are underway. It is concluded that the use of POU/POE technology has gained wider acceptance in the remediation of hazardous waste sites where drinking water is contaminated. (See also W91-05694) (MacKeen-PTT)
W91-05718

NEW DEVELOPMENTS IN POINT-OF-USE/POINT-OF-ENTRY DRINKING WATER TREATMENT.
Ametek, Inc., Sheboygan, WI.
G. L. Hatch.
IN: Point-of-Use/Entry Treatment of Drinking Water. Noyes Publications, Park Ridge, New Jersey. 1990. p 129-135. 4 fig, 4 tab, 26 ref.

Descriptors: *Disinfection, *Drinking water, *Point-of-entry water treatment, *Point-of-use water treatment, *Public health, *Water quality, *Water treatment, Bacteria, Halogenated resins, Ion exchange, Microorganisms, Radon, Reverse osmosis, Viruses, Water quality standards.

New developments in the treatment of drinking water by point-of-use (POU) and point-of-entry (POE) systems are discussed. Recent developments in POU/POE technology have involved the application of well-known technologies to contaminants of public health concern. Activated carbon and aeration are being used for radon removal in POE systems, and ultraviolet light and ozonation technologies have been designed into packaged systems hardware for POU/POE application. Reverse osmosis has become a viable treatment method for certain health-threatening inorganic contaminants such as nitrate, fluoride and arsenic. A new technology for water disinfection involves combining a halogen with an ion exchange resin in a POU system. Advantages of the method include: no electrical connections necessary; ease of installation and maintenance; no down time; minimal space requirements; more efficient use of disinfectant; and good potential for integration with other POU technology. It is concluded that currently available POU water treatment technology can be properly combined with halogenated resins to offer another alternative for providing microbiologically safe drinking water. (See also W91-05694) (MacKeen-PTT)
W91-05719

BIOLOGICAL REMOVAL OF IRON FROM GROUNDWATER.
Hunter District Water Board, Newcastle (Australia). Water Investigation and Planning Section.
M. N. Viswanathan, and B. Boettcher.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1437-1446, 1991. 6 fig, 1 tab, 11 ref.

Descriptors: *Biodegradation, *Groundwater, *Iron, *Organic matter, *Water treatment, Biological oxidation, Biological reactors, Filters, Groundwater chemistry, Heterotrophic bacteria, Humic acids, Iron bacteria, Organic acids, Water treatment facilities, Well water.

Most of the soluble iron in groundwater exists in complexes with organic matter. Removal of iron, complexed with organic matter, is difficult and requires the use of a strong oxidant such as ozone, chlorine, etc. This increases capital and operating costs of water treatment plants. Iron oxidizing bacteria such as Gallionella ferruginea are known to oxidize iron and derive the energy for the reduction of CO2. A biological reactor was developed, based on these principals, to remove iron from groundwater. The reactor was successful in reducing iron levels in groundwater from 2.5-3 mg/l down to about 0.1 mg/l. It was observed that, apart from G. ferruginea, Sphaerotilus were also present in the reactor column. No major problems with respect to clogging of filters or the reactor column were experienced. (Author's abstract)
W91-05751

EFFECT OF SHORT-TERM AND LONG-TERM CHANGES IN HYDRAULIC CONDITIONS ON NITRIFYING BIOFILM.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
For primary bibliographic entry see Field 5D.
W91-05756

APPLICATION OF FIBER ADSORBENTS IN WATER TREATMENT.
Tokyo Univ. (Japan). Inst. of Industrial Science.
For primary bibliographic entry see Field 5D.
W91-05774

POLLUTANT ADSORPTION ONTO ACTIVATED CARBON MEMBRANES.
Ecole Nationale Superieure de Chimie de Rennes (France). Lab. de Chimie des Nuisances et Genie de l'Environnement.
For primary bibliographic entry see Field 5D.
W91-05775

STEADY STATE PERFORMANCE OF ACTIVATED CARBON CONTACTORS.
Illinois Univ. at Urbana-Champaign. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W91-05777

REMOVAL OF TRIHALOMETHANE PRECURSORS FROM RIVER AND LAKE WATER BY ACTIVATED CARBON ADSORPTION.
Meiji Univ., Kawasaki (Japan). Dept. of Industrial Chemistry.
Y. Takeuchi, Y. Suzuki, A. Koizumi, and N. Soeda.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1687-1694, 1991. 11 fig, 3 tab, 6 ref. Japanese Ministry of Education, Science and Culture Grant in Aid for Special Projects No. 63602002.

Descriptors: *Activated carbon, *Adsorption, *Biodegradation, *Chemical precipitation, *Filtration, *Trihalomethanes, *Water treatment, Chlorination, Chlorine, Coagulation, Drinking water, Total organic carbon.

A comprehensive study was undertaken to clarify the method of reducing trihalomethane (THM) and its precursors from river and lake water in view of drinking water purification standards. Sources of water were selected from lakes and rivers in Eastern Japan. The water samples were then subjected to biological treatment and coagulative precipitation prior to the use of an activated carbon adsorption process. Both granular activated carbon and activated carbon fiber were used in series. Experimental results indicated that activated carbon adsorption was effective in removing trihalomethane precursors with molecular weights below 300. In addition, when coagulative precipitation was carried out effectively, water soluble organic compounds with molecular weights greater than 3000 were removed. One outcome of the investigation revealed a strong relation between total organic carbon (TOC) and the trihalomethane formation potential (THMFP) of raw and treated samples. The relation changed depending on the extent of biological treatment. Though the chemical structure of substances which may cause trihalomethane formation was not clear, the content of ammoniacal nitrogen was believed to be responsible for a reduction in the amount of trihalomethane produced when chlorine was added to the water samples. However, this does not mean that the reduction of the chlorine dose could be achieved simply by biological treatment. (Korn-PTT)
W91-05778

CHARACTERISTICS OF METAL-POLYSILICATE COAGULANTS.
Suido Kiko Kaisha Ltd., Tokyo (Japan). Div. of Research and Development.
T. Hasegawa, K. Hashimoto, T. Onitsuka, K. Goto, and N. Tambo.
Water Science and Technology WSTED4, Vol. 23, No. 7/9, p 1713-1722, 1991. 16 fig, 5 ref.

Descriptors: *Chemical coagulation, *Flocculation, *Polymers, *Wastewater treatment, *Water treatment, Coagulation, Color removal, Electrophoresis, Hydrogen ion concentration, Metal complexes, Silica, Silicates, Turbidity.

The recent development of polymer coagulants and flocculation aids has contributed to the improvement of wastewater treatment processes. A study investigated the use of polymerized silicic acid as one of the fundamental substances in an inorganic polymer coagulant. The silicic acid used in the tests was polymerized in an acidic region to obtain a higher molecular weight and longer stability. Metal ions were then introduced, under acidic condition, to the polysilicic acid to give charge-neutralizing capability. The results of the study revealed that the molar ratio of silica to metal ions became an important factor in examining the pH range suitable for coagulation. In addition, with higher molecular weights, the resulting flocs are very tough, and so the new inorganic polymer coagulant could achieve much higher settling flocs in terms of both turbidity and color removal. (Korn-PTT)
W91-05781

PARAMETER ESTIMATION FOR WATER DISTRIBUTION NETWORKS.
Arizona Univ., Tucson. Dept. of Civil Engineering.
K. E. Lansey, and C. Basnet.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 126-144, 1991. 4 fig, 13 tab, 15 ref.

Descriptors: *Hydraulic engineering, *Network design, *Water conveyance, *Water distribution, Algorithms, Automation, Pipe flow, Pipes, Pressure head, Simulation analysis, Water demand.

Calibration of a water distribution network is a long, tedious task, if analyzed by an engineer, with no guarantee of determining the proper system parameters. In addition, more utilities are moving toward automated control and wish to estimate the state of the network based upon telemetry data. A rigorous, nonlinear programming algorithm, which incorporates a network simulation model, has been developed to solve these problems. The model is capable of analyzing one or more independent demand patterns, or extended period simulations, or both. The model assumes the measurements are exact and has an objective of minimizing the sum of the squares of absolute values of the differences between observed and estimated values of pipe flows and nodal pressure heads. The model consistently finds optimal solutions with the objective function equal to zero with exact data. However, the estimated parameters (pipe roughness coefficients, valve settings, and nodal demands) are not always the true values, which points to a need to collect sufficient quantities of high-quality data. (Author's abstract)
W91-05794

WILDERNESS WATER PURIFICATION.
PRODECO Environmental Systems Div., Kenmore, WA.
K. Coralline.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 13-15, January 1991. 1 fig, 1 tab.

Descriptors: *Alaska, *Potable water, *Reverse osmosis, *Water quality management, *Water treatment, Membrane filters, Water costs, Water treatment facilities, Wilderness areas.

A fish-processing plant in remote Ekuk, Alaska, has suffered severe water quality problems. Before the 1990 season began, the company decided to improve the domestic water supply, drawn from three wells and a gravity-fed source from a lake two miles away. The decision-making process required consideration of various alternatives, based mainly on the cost per gallon output. Distillation and mechanical filtration were eliminated because of cost and complexity, respectively. Reverse osmosis (RO) was chosen because of the relatively low cost and simplicity of its these step process: dual media filtration, acid adjustment, and RO. The system uses membrane elements to provide cross-flow filtration, which repels all bacteria, viruses, and pyrogens. The process produces 32 gal/min of permeate which is pumped 60 ft up into the camp's high water tank. The remaining concentrate (not potable, but environmentally safe) is dumped. Over 75% of the water put through the system is recovered as potable water. The RO water costs about $1-$1.50/1000 gal, or about 0.1-0.15 cent/gal. Installation involved laying a concrete foundation for the system, building a 440 sq-ft filtration house around the equipment, charging the dual media filter, and operator training. The cost of the equipment--not including the foundation, house, or installation--was just under $80,000. (Fish-PTT)
W91-05803

POTABLE WATER REUSE.
CH2M/Hill, Denver, CO.
For primary bibliographic entry see Field 5D.
W91-05809

APPLICATION OF INAA AND PIXE ON THE ANALYSIS OF NUTRITIONAL AND TOXICOLOGICAL ELEMENTS IN SAMPLES OF DRINKABLE WATER.
Florence Univ. (Italy). Dipt. di Fisica.
P. Blasi, G. Capannesi, A. Cecchi, F. Lucarelli, and F. A. Sedda.
Biological Trace Element Research BTERDG, Vol. 26/2, p 363-374, July/December 1990, 4 fig, 5 tab, 9 ref.

Descriptors: *Contamination, *Domestic water, *Drinking water, *Neutron activation analysis, *Trace elements, *Water analysis, *X-ray spectroscopy, Aluminum, Arno River, Florence, Heavy metals, Italy, Phosphorus, Plumbing, Silicon, Water sampling, Water treatment.

Multielemental detection using Instrumental Neutron Activation Analysis (INAA) and Photon-induced X-ray Emission (PIXE) analysis were used to measure the concentrations of 52 elements in the drinkable water of Florence, Italy. The samples were taken in seven private homes after an extended flow period, and from the inlet and outlet sides of the municipal aqueduct. No chemical treatment was performed on the samples before or after irradiation. On the basis of an appropriate combination of the analytical techniques, employing a thermalized column consisting of a 70 cm long pipe filled with heavy water having a neutron flux of 4,000,000,000 n/sq cm/s in conjunction with INAA, a procedure for the determination of aluminum which eliminated the interferences of high concentrations of Si and P was developed. Si comes primarily from the sand filters used during the potabilization process but P is present in compound forms in the Arno river. During the flocculation step of the water potabilization process, the concentrations of the heavy metals were reduced to very low levels. The results of analysis of water samples from private homes are affected by the corrosive effect of the water itself on the pipelines. The effect is increased by the addition of chlorine, and as a consequence levels of Cu, Zn, Cd, and Pb were higher in comparison with those obtained in samples taken at the aqueduct. An increase by a factor of 10 was noted in the concentration of these four elements after a period of no flow. (Doyle-PTT)
W91-05899

BACTERIAL COLONIZATION OF DOMESTIC REVERSE-OSMOSIS WATER FILTRATION UNITS.
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
P. Payment.
Canadian Journal of Microbiology CJMIAZ, Vol. 35, No. 11, p 1065-1067, November 1989. 3 fig, 1 tab, 7 ref.

Descriptors: *Bacterial analysis, *Domestic water, *Drinking water, *Filtration, *Reverse osmosis, *Water treatment, Acinetobacter, Activated carbon, Alcaligenes, Chromobacterium, Colonization, Flavobacterium, Potable water, Pseudomonas, Water analysis.

Bacterial regrowth is a major problem in water distribution systems as well as in domestic water filtration units using activated charcoal. In order to study this problem the bacterial content of water from the reservoirs of 300 reverse-osmosis units installed in households were analyzed. The heterotrophic plate counts on R2A medium (20 and 35 C) ranged from 0 to 10,000,000 colony forming units per milliliter (cfu/mL). Most reservoirs contained water with bacterial counts between 10,000 and 100,000 cfu/mL. The bacteria identified were Pseudomonas (not aeruginosa), Alcaligenes or Moraxella, Acinetobacter, Flavobacterium, and Chromobacterium. The units appeared to be colonized by only one species at a time. The average counts from these units were several orders of magnitude above those of tap water. The bacterial species detected are not recognized pathogens through ingestion and should not pose any particular health risk when found in drinking water. (White-Reimer-PTT)
W91-05939

SUBCHRONIC TOXICITY STUDY OF OZONATE AND OZONATED/CHLORINATED HUMIC ACIDS IN SPRAGUE-DAWLEY RATS: A MODEL SYSTEM FOR DRINKING WATER DISINFECTION.
Health Effects Research Lab., Cincinnati, OH.
F. B. Daniel, M. Robinson, H. P. Ringhand, J. A. Stober, and N. P. Page.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 93-98, January 1991. 3 tab, 29 ref.

Descriptors: *Chlorination, *Disinfection, *Drinking water, *Humic acids, *Ozonation, *Toxicity, *Water treatment, Bioassay, Kidneys, Liver, Rats, Tissue analysis.

A search for alternative processes to the disinfection of drinking water by chlorination is underway based on the concern over hazardous byproducts formed by chlorination. Ozonation represents an attractive alternative. The comparative toxicity of exposure to drinking water containing gram per liter levels of either nondisinfected humic acids or humic acids that had been ozonated or ozonated and subsequently chlorinated was evaluated. Male and female Sprague-Dawley rats were administered drinking water containing humic acids either nondisinfected or following ozonation (O3) or ozonation/chlorination (O3/Cl2) for 90 consecutive days. Test animals drank either of two concentrations of humic acids, 0.25 and 1.0 g/L total organic carbon (TOC), while controls received phosphate-buffered, distilled water. No consistent significant treatment-related effects were observed in body weight gain, organ weights, food or water consumption, or hematological and clinical chemistry parameters. No target organs were identified from the histopathological examination of the tissues. The most significant observation, an increase in liver to body weight ratio for the male animals in the 1.0 g/L O3/Cl2 humic acid group, was not observed in any other group, nor was it corroborated via any biochemical measurements or histopathological analysis. Kidney lesions, primarily chronic progressive nephropathy were a common observation in both controls and treated groups with no apparent relationship to either humic acid concentration or the disinfection process. (Author's abstract) (White-Reimer-PTT)
W91-05951

IDENTIFICATION OF OXIDIZED AND REDUCED FORMS OF THE STRONG BACTERIAL MUTAGEN (Z)-2-CHLORO-3-(DICHLOROMETHYL)-4-OXOBUTENOIC ACID (MX) IN

EXTRACTS OF CHLORINE-TREATED WATER.
Abo Akademi, Turku (Finland). Dept. of Organic Chemistry.
L. Kronberg, R. F. Christman, R. Singh, and L. M. Ball.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 99-104, January 1991. 4 fig, 4 tab, 23 ref.

Descriptors: *Chlorination, *Disinfection, *Drinking water, *Mutagens, *Water treatment, Ames test, Fulvic acids, Humic acids, Oxidation, Public health, Reduction.

Concern for the potential human health hazards associated with chlorinated drinking water has been heightened by the widespread recognition in recent years of mutagenic activity exhibited by the nonvolatile fraction. Oxidized and reduced forms of (Z)-2-chloro-3-(dichloromethyl)-4-oxobutenoic acid (MX) and the oxidized form of its geometric isomer (EMX) were synthesized, evaluated for mutagenic potency in the Ames assay, and quantitatively determined in chlorinated aqueous solutions of fulvic acids, in chlorinated natural humic acid, and in chlorinated drinking water. The compounds were found in chlorinated drinking waters at concentrations equal to or greater than MX. In the Ames assay the pure oxidized compounds were nonmutagenic at the dose levels tested while the reduced form of MX was weakly mutagenic relative to MX. These finding suggest that the cis arrangement of the dichloromethyl and chlorine groups around the carbon-carbon double bond and the presence of the aldehyde function strongly enhance the mutagenic response. It is possible that MX and its analogues are formed through sequential oxidations of a common precursor unit in the humic acid macromolecule. (Author's abstract) (White-Reimer-PTT)
W91-05952

5G. Water Quality Control

SUPERCRITICAL FLUID EXTRACTION OF COAL TAR CONTAMINATED SOIL.
Cook Coll., New Brunswick, NJ. Dept. of Food Science.
X. Xu, X. Wang, R. Bartha, and J. D. Rosen.
Environmental Science and Technology ESTHAG, Vol. 24, No. 11, p 1732-1738, November 1990. 4 fig, 8 tab, 7 ref.

Descriptors: *Cleanup operations, *Coal tars, *Polycyclic aromatic hydrocarbons, *Site remediation, *Soil contamination, *Supercritical fluid extraction, *Water pollution prevention, Carbon dioxide, Methanol, Mutagenicity, Separation techniques, Soil analysis, Toxicity.

A coal tar contaminated soil containing over 0.1% polycyclic aromatic hydrocarbons (PAH) was treated by supercritical fluid extraction with carbon dioxide/methanol. A 7-h extraction period resulted in removal of 92% of the PAH and other contaminants. This was reflected in the virtual elimination of toxicity and mutagenic activity as measured by two short-term assays. Shorter extraction periods gave lesser, but still significant, toxicity and mutagenic activity reductions. (Author's abstract)
W91-04953

REEUWIJK LAKES: A FIVE YEARS WATER QUALITY STUDY IN AN EUTROPHIC ECOSYSTEM.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04962

MODELLING PHOSPHORUS FLUXES IN THE HYPERTROPHIC LOOSDRECHT LAKES.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5C.
W91-04963

EFFECTS OF LIMING ON NUTRIENT LIMITATION OF EPILITHIC ALGAE IN AN ACID LAKE.
West Chester Univ. of Pennsylvania. Dept. of Biology.
G. W. Fairchild, and J. W. Sherman.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 133-147, 1990. 4 fig, 2 tab, 34 ref. NSF Grant No. BSR-9604543.

Descriptors: *Acid rain effects, *Acidic lakes, *Algae, *Lake restoration, *Liming, *Nutrients, Alkalinity, Biomass, Carbon, Chlorophyll a, Hydrogen ion concentration, Lake Earnest, Limiting nutrients, Limnology, Nitrogen, Pennsylvania, Phosphorus.

The process of lake acidification and lake restoration frequently involve major changes in dissolved inorganic carbon (DIC) and dissolved inorganic nitrogen (DIN), both of which may potentially limit algal growth. The nutrient limitation of benthic algal biomass and species abundances was evaluated during the summers of 1987 and 1989, before and after the liming of Lake Earnest (NE Pennsylvania) in November 1988. Limestone addition caused immediate increases in pH from 4.7 to 7.2. Alkalinity was -34 microeq/L in summer 1987 but rose to 620 microeq/L in summer 1989 whereas DIN declined from 10.7 micromol/L to 1.1 micromol/L. The algae were sampled after 45 to 46 d from clay flower pot substrates diffusing combinations of N, P and C. Algal biomass was strongly C limited in 1987, but NP-limited in 1989. Mougeotia species which comprised > 99% of total algal biovolume prior to liming, decline to < 1% of the community on control substrates, while Oedogonium species increased to 43% of total biovolume in 1989. The stimulation of chlorophyll-a accrual with C-enrichment during 1987 was consistent with the later increase in chlorophyll-a on control substrates following liming. Species enhanced by the diffused nutrients, however, generally differ from those which dominated the natural community. (Author's abstract)
W91-04974

CHLORIDE IN THE PORE WATER AND WATER COLUMN OF ONONDAGA LAKE, N.Y., U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
For primary bibliographic entry see Field 5B.
W91-04983

RISK FEEDBACK: AN IMPORTANT STEP IN RISK COMMUNICATION.
Risk Writers Ltd., St. Paul, MN.
For primary bibliographic entry see Field 5F.
W91-05021

GROUNDWATER REMEDIATION PLAN.
ARI Technologies, Palatine, IL.
C. Owano, and L. C. Hardison.
Water Engineering and Management WENMD2, Vol. 137, No. 10, p 25-27, October 1990. 1 fig.

Descriptors: *Cleanup operations, *Groundwater pollution, *Industrial wastes, *Project planning, *Site remediation, *Trichloroethane, Air stripping, Catalysis, Observation wells, Pumping, Risk assessment, Volatile organic compounds.

A groundwater remediation plan was developed and installed at a manufacturing site located in Woodstock, Ill. that was contaminated with trichloroethane. A preliminary study indicated that the contamination was contained within five acres of the 29-acre site and the VOC contamination was detected only at relatively shallow depths below the water table, averaging 10-12 ft deep. A health risk assessment indicated that no contamination of the three water wells on the property or any off-site aquifer was involved. The work plan requires pumping the contaminated groundwater from the upper aquifer, air-stripping the contaminants and treating the stripped air with a catalytic oxidation chlorooorganic-destruction device. Then the cleaned water will be reinjected into the ground. To evaluate the effectiveness of the groundwater remedial program, six monitoring wells will be sampled on a quarterly basis. (Feder-PTT)
W91-05033

MAKING GROUNDWATER SAFE TO DRINK.
Metcalf and Eddy, Inc., Wakefield, MA.
D. Brocard, and C. Haggar.
Water Engineering and Management WENMD2, Vol. 137, No. 10, p 28-31, October 1990. 2 fig.

Descriptors: *Cleanup operations, *Drinking water, *Groundwater pollution, *Groundwater quality, *Monitoring, *Site remediation, *Water pollution treatment, Feasibility studies, Model studies, Path of pollutants, Regulations, Water pollution sources.

Drinking water regulations for groundwater are driving the industry to account for sources of groundwater contamination, learn the techniques used to access and monitor groundwater quality and determine how to tailor treatments to groundwater cleanup projects. A multitude of groundwater contamination sources result from a variety of irrigation and industrial/municipal uses of groundwater. Contaminants include inorganic compounds, metals, volatile organic compounds, synthetic organics, pesticides and PCB's, bacteria, viruses and radioactive substances. The steps to groundwater cleanup require a site assessment and remedial investigation/feasibility study. Final steps include cleanup system design, implementation, operations and ongoing monitoring. Computer models are also used to simulate groundwater flow and contaminant transport. Vadose-zone monitoring provides early warning signs that leachate is moving toward the groundwater and identifies the movement of contamination as closed to the source as possible. Treatment technology is tailored to the specific contaminants. Activated carbon effectively filters many halogenated and non-halogenated volatiles and non-volatiles. Air stripping is used on either halogenated or non-halogenated volatile organic compounds. Non-halogenated non-volatile compounds such as heavy fuel oils and household waste respond well to biological treatment. Treatment of heavy metals is limited to separation technologies since these contaminants are elements that cannot be destroyed. More than one contaminant is usually present in groundwater aquifers and often a combination of treatment forms is appropriate. (Feder-PTT)
W91-05034

IMPROVING STRATEGIES FOR CHEMICAL SPILLS.
Ohio River Valley Water Sanitation Commission, Cincinnati.
P. A. Tennabt, and L. H. Betscher.
Water Engineering and Management WENMD2, Vol. 137, No. 10, p 32-34, October 1990. 2 fig.

Descriptors: *Administrative agencies, *Interstate commissions, *Ohio River basin, *Spills, *Water pollution control, *Water quality, Emergency planning, Monitoring, Organic pollutants, Public relations, Water policy, Water quality standards.

The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate water pollution control agency established by a compact signed in 1948 by representatives of the states of IL, IN, KY, NY, OH, PA, VA and WV, with the approval of the U.S. Congress. A full-time staff carries out programs in the areas of water-quality monitoring, data analysis, toxics control, pollution-control standards, emergency response and public information. The detection system provides daily analyses for 23 purgeable organic compounds at 14 locations. As a result of the ORSANCO organics detection system, deliberate spills of harmful chemicals into the Ohio River and its tributaries have significantly declined. (Feder-PTT)
W91-05035

COMPREHENSIVE SURVEY OF THE HYPERTROPHIC LAKE TUUSULANJARVI: NUTRIENT LOADING, WATER QUALITY AND PROSPECTS OF RESTORATION.
Keski Uusimaa Inter-Municipal Corp. for Water Pollution Control, Kerava (Finland).

M. Pekkarinen.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 13-25, 1990. 8 fig, 1 tab, 31 ref.

Descriptors: *Eutrophic lakes, *Finland, *Lake Tuusulanjarvi, *Lake restoration, *Pollution load, *Water pollution control, *Water pollution effects, Aeration, Biomanipulation, Fish, Lake Rusutjarvi, Lake sediments, Paijanne Tunnel, Phosphorus, Phosphorus removal, Trophic level, Water quality.

Basic characteristics of the shallow, pelotrophic Lake Tuusulanjarvi (Finland: mean depth 3.2 m, area 6.0 sq km) are described. The lake is situated in a densely populated agricultural area in southern Finland. Studies of nutrient loading and water quality and potential restoration measures are reviewed briefly. Heavy eutrophication began in the mid-1950s and the lake was at its worst in the early 1970s. Since the beginning of winter aeration in 1972 the lake began to recover slowly. In 1979 the phosphorus load was cut by 50% when the discharge of wastewater from the town of Jarvenpaa ceased. Within some years the condition of the lake improved noticeably due to decreased nutrient levels and phytoplankton biomass. On the other hand, the diffuse phosphorus load (0.75 g/sq m/yr) is sufficient to keep the lake hypertrophic unless further measures are taken. The diffuse phosphorus load can be decreased by 20 or 30%. In addition, the internal load should be controlled by several methods, although none of them alone will be sufficient. Dilution with a small amount of added water (0.1-0.2 cu m/sec) pumped from the Paijanne tunnel through Lake Rusutjarvi is to be started in 1992. The continuation of aeration will be necessary as well. Biomanipulation will first be directed to stocking of carnivorous fish. Eliminating water level regulation, which would be beneficial to fishing, is also under consideration. Sediment will be removed from some parts of the basin, but the procedure will be expensive because of the lack of suitable sediment disposal sites near the lake. (Rochester-PTT)
W91-05061

PALEOLIMNOLOGICAL INVESTIGATION OF THE EUTROPHICATION HISTORY OF LAKE TUUSULANJARVI, SOUTHERN FINLAND.
Joensuu Univ. (Finland). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W91-05062

MODELING OF WATER QUALITY IN LAKE TUUSULANJARVI.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
O. Varis, and J. Kettunen.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 43-54, 1990. 13 fig, 1 tab, 48 ref.

Descriptors: *Computer models, *Eutrophic lakes, *Finland, *Lake Tuusulanjarvi, *Lake restoration, *Model studies, *Monitoring, Decision making, Limnology, Management planning, Mathematical models, Phytoplankton, Sampling, Statistics, Water quality.

Lake Tuusulanjarvi (Finland) has been subjected to regular water quality monitoring for almost three decades. Sampling for standard physical and chemical analyses has been running on a monthly basis. Phytoplankton sampling has been concentrated in the summer months. The data set was analyzed using a selection of computerized mathematical and statistical techniques, with both methodological and limnological scopes (trend analysis, multivariate analysis, mechanistic modeling, state and parameter estimation, rule-based expert systems, optimal design of observations, and Bayesian decision theory). Many of the substudies are still in progress, but all the approaches reviewed have potential in practical decision making or in scientific research. The study demonstrated that, even in the case of a single lake, it pays to apply a number of complementary approaches, illuminating the problems from different problem settings and at different phenomenological levels. The results of static and dynamic data analyses serve as the basis of inference, in both the ecological and decision-making contexts. Optimization is useful in the evaluation of large-scale management of decisions, such as the design of further sampling and monitoring, and the socioeconomic acceptability of further lake restoration strategies. (Rochester-PTT)
W91-05063

OCCURRENCE OF VEGETATED BUFFER ZONES ALONG BROOKS IN THE CATCHMENT AREA OF LAKE TUUSULANJARVI, SOUTH FINLAND.
J. Keskitalo.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 55-64, 1990. 5 fig, 4 tab, 18 ref.

Descriptors: *Bank erosion, *Buffer zones, *Catchment areas, *Erosion control, *Finland, *Lake Tuusulanjarvi, *Vegetation, *Water pollution prevention, Bank protection, Bioindicators, Duckweed, Eutrophication, Nettles, Nutrients, Path of pollutants.

Vegetated buffer zones along brooks in arable land were studied in the catchment of Lake Tuusulanjarvi (Finland). The buffer zone usually was narrow or absent (mean breadth 1.3 m, median 0.3 m). The conditions, were, however, rather good at one brook, Vuohikkaanoja (mean depth 5.0 m, median 1.5 m). On the west shore of Tuusulanjarvi, low-lying cultivated areas evidently cause significant nutrient and soil losses into the lake. In general brook slopes were covered by vegetation, and bad erosion occurred only at some places. The vegetation on the slopes and buffer zones was luxuriant at the mouths of brooks, but less rich in the middle and upper course. Urtica dioica frequently indicated increased nutrient losses from the arable land. The aquatic plant Lemna minor was abundant in some brooks with narrow buffer zones. An improvement of the buffer zone conditions would be an effective means of decreasing nutrient load into Lake Tuusulanjarvi. Breadth of the vegetated buffer zone in the catchment area should everywhere be at least 1-2 m and in places tens of meters. (Author's abstract)
W91-05064

VEGETATED BUFFER ZONE EXAMINATIONS ON THE VANTAA RIVER BASIN.
Water Protection Association of the Vantaa River and Helsinki District (Finland).
For primary bibliographic entry see Field 4D.
W91-05065

PRELIMINARY OBSERVATIONS ON THE EFFECTS OF LIMING TO THE FISH POPULATIONS OF SMALL ACIDIC LAKES IN SOUTHERN FINLAND.
Finnish Game and Fisheries Research Inst., Helsinki. Fisheries Div.
J. Raitaniemi, and M. Rask.
Aqua Fennica AQFEDI, Vol. 20, No. 1, p 115-123, 1990. 4 fig, 2 tab, 30 ref.

Descriptors: *Acid rain, *Finland, *Lake restoration, *Liming, Acidic water, Alkalinity, Fish populations, Hydrogen ion concentration, Perch, Performance evaluation, Roach.

Six acidified lakes (pH 5.3-6.2) in Finland were sampled before or soon after liming to determine the structure of the fish populations and again 2-3 yr after liming. Three, similarly acidified but not limed, lakes were chosen as control lakes and were examined in the same way. Perch (Perca fluviatilis L.) was the dominant species in the catches of most lakes both before and after neutralization. The species relationships changed noticeably in only one lake, where the small roach (Rutilus rutilus L.) population still left before the liming reproduced successfully in the next spring after neutralization. Half the catch consisted of roach 2 yr after liming. At the time of fishing this lake had the highest alkalinity (0.16 millimole/liter) of the limed lakes. Increased growth rates were recorded if both young and old roach in comparison with the time before liming. No effects of liming were detected in catches or growth of perch in the lakes. if alkalinity can be maintained at a high level, populations of sensitive fish species can succeed in limed lakes. (Author's abstract)
W91-05068

U.S. TACKLES LEAKING TANKS.
V. Fairweather.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 12, p 47-49, December 1990.

Descriptors: *Oil pollution, *Regulations, *Underground storage tanks, *Water pollution prevention, Cathodic protection, Cost analysis, Environmental Protection Agency, Fiberglass, Leakage, Pipes, Texas.

The Underground Storage Tank (UST) program was established to deal with the serious risk to groundwater associated with 2 million underground petroleum storage tanks in the United States, about 25% of which are leaking. The Environmental Protection Agency has promulgated regulations with a series of deadlines, which began in 1989 for tanks installed before 1969. These deadlines cover site investigation, bringing tanks into compliance with UST and for remediation where necessary. Compliance includes options for corrosion and leak protection in tanks and piping, providing for spills during deliveries, and monitoring and testing for the life of the tanks. Examples of tank owners complying with UST program include the city of Houston, Texas, which had some 50 city tanks at various fueling sites. The 5-yr plan for correcting Houston tank problems will cost $5 million. To meet UST regulations all new tanks have to be steel coated with fiberglass or have a cathodic protection system. The average cost of removing an old tank and installing a new tank has been estimated at about $80,000-90,000, of which about $10,000 is for the new tank itself. A 1988 EPA study of tank failures concluded that tank wall thickness is more important than tank age for predicting tank failure. Future problems that will be especially challenging include disposing of contaminated soils and determining whether future alternative fuels will worsen corrosion problems. (Rochester-PTT)
W91-05070

PLANTS PROTECT WATER BODIES.
I. M. Kuturin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 49-50, 1990. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 40-41, January, 1990.

Descriptors: *Aquatic plants, *Water pollution control, *Water quality, *Watershed management, Agricultural runoff, Algae, Bioindicators, Ecology, Fertilizers, Forests, Macrophytes, Nonpoint pollution sources, Nutrients, Photosynthesis, Surface water.

The role of plants (algae, aquatic macrophytes, and forest trees) in forming and maintaining the quality of surface water and in protecting surface water bodies from pollution is considerable. Photosynthesis by algae produces organic matter and releases oxygen. Algae improve the health of water bodies by releasing bactericidal substances that inhibit pathogenic microfauna. Algae also serve as excellent indicators of decreased water quality. Excessive growth of algae stimulated by fertilizer runoff into water bodies can create algal pollution. Higher aquatic vegetation (macrophytes) also play a considerable role in improving the health of water bodies, including such activities as removing oil, petroleum products, biogenic elements, and mineral salts from surface waters. Harvesting of macrophytes after they have absorbed nutrients is a way to employ aquatic vegetation in pollutant removal. Forests reduce water pollution by pesticides, biogenic elements, and salts contained in runoff from fields. The natural mechanism of protecting water bodies from anthropogenic influences is rather stable under conditions of ecological equilibrium. However, it is quite fragile and cannot perform its functions after considerable disturbance of the ecological equilibrium. (Rochester-PTT)
W91-05087

ACUTE TOXICITY OF THE NATURAL ALGICIDE, CYANOBACTERIN, TO DAPHNIA MAGNA.
Minnesota Univ., Minneapolis. Div. of Environmental Health.
N. A. Klapes.
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 2, p 167-174, October 1990. 1 fig, 2 tab, 17 ref.

Descriptors: *Acute toxicity, *Algal control, *Algicides, *Cyanophyta, *Daphnia, *Risk assessment, *Toxicology, Algal blooms, Environmental effects, Lethal limit, Structure-activity relationships.

Cyanobacterin is a potent photosynthetic inhibitor produced as a secondary metabolite by the filamentous, freshwater cyanobacterium Scytonema hofmanni. With a spectrum of activity encompassing species of cyanobacteria and eukaryotic algae as well as higher plants, cyanobacterin might be utilized as a commercial algicide for algae waterbloom control. As a component of the preliminary environmental risk/hazard evaluation of this proposed application, the acute toxicity of cyanobacterin to the planktonic crustacean Daphnia magna was assessed. Based on five trials, the 48-h LC50 for D. magna was determined to be approximately 1.37 microg/ml (range: 0.78-2.58 microg/ml). In addition, a significant percentage of the surviving daphnids were completely immobile at the end of the 48-h exposure period. These results give strong indication that cyanobacterin and/or its residues exhibit some nontarget organism lethal effects at projected use concentration levels. Furthermore, estimates of partition coefficients and bioconcentration factor, generated through quantitative structure-activity relationships, suggest that sediment, suspended particulates, and biota may serve as major compartments of cyanobacterin partitioning in an aquatic ecosystem. Before cyanobacterin should be further considered for application as a commercial algicide, a rigorous evaluation of nontarget organism lethal effects and environmental fate is required. (Author's abstract)
W91-05105

USE OF SELECTED AUTOCHTHONOUS SOIL BACTERIA TO ENHANCE DEGRADATION OF HYDROCARBONS IN SOIL.
Universidad Nacional de La Plata (Argentina). Facultad de Ciencias Exactas.
G. I. Vecchioli, M. T. Del Panno, and M. T. Painceira.
Environmental Pollution ENPOEK, Vol. 67, No. 3, p 249-258, 1990. 1 fig, 3 tab, 19 ref.

Descriptors: *Biodegradation, *Bioremediation, *Decontamination, *Fate of pollutants, *Microbial degradation, *Soil bacteria, *Water pollution treatment, Hydrocarbons, Industrial wastes, Land disposal, Oil wastes, Soil contamination, Soil treatment.

A mixed population of soil hydrocarbon-degrading bacteria was used to accelerate the biodegradation of a petrochemical waste. In untreated control soils, hydrocarbon-degrading bacteria were found in the 100,000 cfu/g range. The addition of a 10% loading rate of an aromatic hydrocarbon mixture increased the number of hydrocarbon degraders by two to three orders of magnitude. An aromatic storage tank bottom was mixed with soil (10% w/w). After a month, 43% of the hydrocarbons were degraded in uninoculated and in fertilized soil, while 65% were degraded in soil inoculated with stains of hydrocarbon-degrading bacteria. Two isolates were identified as members of the genus Pseudomonas and the third was tentatively classified as an Alcaligenes sp. The strains grown in nutrient supplemented vermiculite at room temperature in the absence of hydrocarbons preserved their hydrocarbon-degrading abilities for at least a month. It is concluded that biodegradation of heavily polluted soils such as those found in land treatment facilities or accidental spills may be enhanced by inoculation with selected indigenous bacteria. (MacKeen-PTT)
W91-05114

CAN THE UNITED STATES AFFORD BIOMONITORING.
L. F. Jones.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 59-66, 17 ref.

Descriptors: *Bioindicators, *Biotechnology, *Monitoring, *Regulations, *Toxic wastes, *Water pollution control, *Water quality standards, Analytical techniques, Clean Water Act, Effluent streams, Testing procedures, Toxicity, Water pollution, Water quality control.

Regulation of toxic pollutants is difficult because of the great number of toxic chemicals that potentially may be discharged to receiving waters, the need to identify and analyze specific toxic chemicals, the changes in toxic effects of a chemical resulting from its reactions with the matrix of constituents in which it exists, and our inability to predict the effects of exposure to combinations of chemicals. Two approaches to water quality toxic control are the chemical-specific approach, which uses analytical chemistry techniques, and the whole-effluent, or toxicity-based, approach, which uses biological techniques to assess effluent discharges. The principal advantages of biological techniques are that: (1) the effects of complex discharges of many known and unknown constituents can be measured only by biological analyses; (2) bioavailability of pollutants after discharge is measured best by toxicity testing; and (3) pollutants for which there are inadequate chemical analytical methods or criteria can be addressed. Toxicity testing protocols involve factors inherent in any procedure which can introduce variability, including: the species chosen for the test; the age and health of the organisms; the test conditions; and the nature of the dilution water. The statutory basis for biomonitoring is the Clean Water Act, as amended by the Water Quality Act (WQA) of 1987, requiring states to identify and list those waters that are adversely affected by pollutants and to prepare individual control strategies that will control point source discharges of toxic pollutants. From industrial and municipal case studies, it is apparent that absolute and final answers do not exist for controlling and investigating whole-effluent toxicity. (See also W91-05137) (Fish-PTT)
W91-05143

BIOTECHNOLOGY APPROACH TO BIOREMEDIATION.
Mississippi Forest Products Utilization Lab., Mississippi State.
A. Borazjani, G. D. McGinnis, L. K. McFarland, M. F. Hannigan, and F. Hendrix.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 67-71, 1 fig, 4 tab, 9 ref.

Descriptors: *Biodegradation, *Bioremediation, *Biotechnology, *Cleanup, *Mississippi, *Wood wastes, Chemical wastes, Fungi, Microbial degradation, Pentachlorophenol, Polycyclic aromatic hydrocarbons, Slurries, Soil contamination, Water pollution treatment.

The contamination of soil and water by woodtreating chemicals is a growing environmental concern in Mississippi and most of the southeastern United States. Two very common components of organic woodtreating wastes are polycyclic aromatic hydrocarbons (PAHs) and pentachlorophenol (PCP). The application of adapted, microbial cultures to polluted areas is demonstrated to be an efficient and economical method for bioremediation of chemical wastes. A study was performed to (1) use two different biological systems to evaluate the biodegradation rate of PAH and PCP in common water; (2) use a bacterial system to determine the biodegradation rate of PCP and PAH in highly contaminated slurry condition; and (3) determine the effectiveness of a fungus in biodegradation of PAH in contaminated soil. Four treatments (checks (no additive), bacterial solution added, bacterial solution and inorganic solution added, and fungal solutions added) with three replications were used. It was found that highly contaminated water, soil, and slurry could be effectively bioremediated by using proper microorganisms and correct methods of treatment. Bioaugmentation was shown to be effective in increasing the biodegradation rate of chemicals in contaminated soil and water. (See also W91-05137) (Fish-PTT)
W91-05144

BIOREMEDIATION DEMONSTRATION UNIT AT WEED, CALIFORNIA.
Mississippi State Univ., Mississippi State.
D. F. Pope, G. D. McGinnis, H. Borazjani, D. Strobel, and J. Wagner.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 72-84, 2 fig, 10 tab.

Descriptors: *Biodegradation, *Bioremediation, *California, *Cleanup, *Microbial degradation, *Soil contamination, *Superfund, *Wood preservatives, Creosote, Feasibility studies, Metals, Pentachlorophenol, Polycyclic aromatic hydrocarbons, Soil bacteria, Soil fungi.

The J. H. Baxter/International Paper/Roseburg Superfund site in the city of Weed, in northern California, has been an active wood treating plant since 1936, using such preservative chemicals as pentachlorophenol, creosote, and metals. The soil at the site is contaminated with the various wood preservatives. As part of a comprehensive site remediation plan, land treatment of the pentachlorophenol and creosote contaminated soils was considered as a treatment alternative. A feasibility study was conducted, consisting of three phases: (1) laboratory studies of microbial degradation of pentachlorophenol (PCP) and creosote contaminated soils; (2) a field demonstration study; and (3) a full-scale land treatment demonstration facility. Phases 1 and 2 have been completed, and show that the levels of nitrogen, phosphorus, and organic carbon in the different soils appear to be adequate for biodegradation. Metal concentrations did not appear to inhibit breakdown rates in the laboratory studies. All classes of polynuclear aromatic hydrocarbons (PAHs) exhibited good breakdown rates in the laboratory. The microbial populations developed readily and were maintained. Acclimated bacteria levels were at moderate to high levels, and fungi populations were particularly high, indicating that good PCP breakdown rates could be expected. In the field study, the best percentage reduction of PAHs, PCP, tetrachlorophenol, and octachlorodibenzo-p-dioxin occurred with moderate starting constituent concentrations and the highest level of added manure; the lowest reduction percentage occurred with the highest starting levels of hazardous constituents and no added manure. The laboratory results were generally confirmed. (See also W91-05137) (Fish-PTT)
W91-05145

COMPUTER METHODS FOR EVALUATING WELLHEAD PROTECTION AREAS.
M. J. Mallory.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 127-135, 3 fig, 2 tab, 3 ref.

Descriptors: *Computer programs, *Groundwater movement, *Mississippi, *Shallow wells, *Water pollution control, *Water pollution prevention, *Well regulations, *Wellhead protection, Flow characteristics, Flow equations, Fortran, Geographic information systems, Groundwater pollution, Surface water data, Well data.

Throughout Mississippi there are approximately 440 shallow (<350 feet deep) public water supply wells that may be vulnerable to surface contamination, depending on the geohydrologic conditions in the vicinity of the wells. One way of preventing contaminated groundwater from entering wells and springs is by establishing areas of protection around them, which necessarily restricts some uses of the land so designated and requires that the

technical basis of the designation be scientifically valid, objective, and unambiguous. Three methods were used in the analysis of flow components near shallow public water supply wells in Mississippi, consisting of the calculated-fixed-radius criterion, the area-of-contribution criterion, and the time-of-travel criterion. The computer program used to calculate and display the boundaries of the areas determined using these three criteria is written in standard Fortran 77, providing an interactive environment for determining wellhead protection areas based on the described criterion. Physical and construction data about wells, containing the hydrologic information needed to determine which public supply water wells might require protection from contamination, are stored in the U.S. Geological Survey's Ground-water Site Information system database. A significant improvement in speed and ease of use might be realized by integrating the calculations of the described program with the graphic display capabilities of a Geographic Information System to obtain a product without the need for manual overlay and preparation. (See also W91-05137) (Fish-PTT)
W91-05153

WHAT SHALL WE DO WITH GARBAGE-DUMP AND LANDFILL LEACHATE.
T.-H. Shih.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 156-165, 5 tab, 25 ref.

Descriptors: *Landfills, *Mississippi, *Solid waste disposal, *Waste disposal, *Waste management, *Wastewater treatment, *Water pollution sources, Aerobic treatment, Anaerobic digestion, Garbage dumps, Groundwater pollution, Incineration, Landfill covers, Landfill linings, Leachates, Regulations, Sanitary landfills, Wastewater facilities.

The garbage dumps and sanitary landfills used for solid waste disposal in the past represent a liability that must be dealt with. As growing populations encroach upon these areas, it is being discovered that the leachates are contaminating the groundwater needed for drinking water. The regulations pertinent to solid waste leachate were studied to consider the feasibility of leachate treatment at existing publicly-owned treatment works (POTWs) and to simulate, through a program written in BASIC language, the oil-fired incineration of such leachate. The new regulation, 40 CFR Part 258, has been added as the guidance for solid waste landfill operation. Together with the Resource Conservation and Recovery Act Subtitle C & D and 40 CFR Part 257, the operations of municipal solid waste and hazardous waste landfill are covered by more complete regulations than before. Garbage dumps no longer will be legal. Groundwater monitoring will be part of the landfill operation. The separation of runoff and leachate are important for wastewater-volume minimization. The roofing principle, separating precipitation and leachates, ideally protects the top of the landfill, and a dependable lining system, preventing the contamination of groundwater, isolates the bottom of the landfill from its surroundings. If aerobic processes are to be used for leachate treatment, effluent recycle with the lowered concentrations and extended detention times may be an option. Anaerobic methods may be considered for landfill-leachate treatment due to the high efficiency and short hydraulic retention times they allow. Leachate incineration may be considered if its organic concentration and operational temperature can be raised sufficiently. (See also W91-05137) (Fish-PTT)
W91-05156

ABILITY OF SOIL UNDER FOREST TO PURIFY FERTILIZER-POLLUTED RUNOFF.
Desnal Anti-Erosion Experimental Station, Ukrainian Institute of Agricultural and Forestry Melioration.
For primary bibliographic entry see Field 5B.
W91-05216

PETROLEUM CONTAMINATED SOILS. VOLUME 2: REMEDIATION TECHNIQUES, ENVIRONMENTAL FATE, RISK ASSESSMENT, ANALYTICAL METHODOLOGIES.
Proceedings of the Second National Conference on the Environmental and Public Health Effects of Soils Contaminated with Petroleum Products, University of Massachusetts, Amherst, September 28-30, 1987. Lewis Publishers, Chelsea, Michigan. 1989. 515 p. Edited by Edward J. Calabrese, and Paul T. Kostecki.

Descriptors: *Soil contamination, *Oil pollution, *Cleanup operations, *Path of pollutants, *Site remediation, Conferences, Risk assessment, Fate of pollutants, Industrial wastes, Public health, Regulations, State jurisdiction, Federal jurisdiction, Research priorities.

A comprehensive assessment is provided of the field of petroleum contamination of soil with respect to the problem (Chapters 1-4) and research (5-9), as well as specific technical areas such as analysis (Chapters 10-13), environmental fate (Chapters 14-16), remedial techniques (Chapters 17-25 and 27), public health assessment (Chapters 26, 28-34) and regulatory approaches (Chapters 35-37). The expertise from federal and state governmental agencies; affected industries, most notable petroleum and electric utilities; private consultants; and academia provides both historical sense of the problems and practical approaches for their solutions within the context of a complex web of regulatory approaches. (See W91-052378 thru W91-05267) (Lantz-PTT) (For Vol. I see W90-03830)
W91-05236

ENVIRONMENTAL REGULATIONS PLACE NEW RESPONSIBILITIES ON PROPERTY OWNERS.
Environmental Realty Services, Nashville, TN.
B. D. Taylor.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 3-7.

Descriptors: *Oil pollution, *Soil contamination, *Regulations, *Environmental protection, *Superfund, *Cleanup operations, Legislation, Public participation, Economic aspects, Legal aspects, Hazardous wastes, Waste disposal, Underground storage tanks.

The courts have found that liability under the Superfund Act was strict (current owners and operations may be accountable for the cost of cleanup); actual responsibility for the problem does not have to be shown. The courts also stated that the necessary proof of causation linking the defendant to a particular waste was relatively loose. Congress amended the Superfund law by adopting the Superfund Amendments and Reauthorization Act of 1986 (SARA), which became effective on October 17, 1986. The act makes it clear that real property owners may be held liable for all costs of cleaning up on-site hazardous substances unless they can prove that they can satisfy the standards for the 'innocent landowner' immunity. To qualify for the immunity, any party to a land purchase agreement or financing agreement that provides for title transfer in the event of default, must be able to show all of the following: (1) The release of a hazardous substance was caused by an act of God or a third party; (2) The property was acquired after the hazardous waste had been disposed of; (3) There was no knowledge and no reason to know that any hazardous substance had been disposed of on-site; (4) Due care with respect to the hazardous substance concerned had been exercised, and/or (5) Precautions against foreseeable acts or omissions of any third party were taken. Businesses likely to feel the greatest impact of these regulations include industrial operations, industrial and agricultural terminal operations, service stations, and anyone buying or selling property with underground storage tanks. (See also W91-05236) (Lantz-PTT)
W91-05237

PROVIDING ENVIRONMENTAL IMPAIRMENT LIABILITY INSURANCE COVERAGE.
Environmental Insurance Management, Inc., McLean, VA.
J. J. Metelski, and W. P. Gulledge.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 9-12.

Descriptors: *Environmental protection, *Insurance, *Legal aspects, *Liability, Pollution control, Economic aspects, Regulation.

The insurance industry faces two major road blocks to the development of pollution liability insurance coverage: (1) The potential liability for gradual pollution coverage under existing general liability coverages using 'occurrence policy forms' intended to cover only sudden or accidental pollution events; and (2) the technical and legal inability of insurers to demonstrate to the courts when a pollution event started and when it should trigger coverage under an insurance policy. First, insurance companies issue one of two types of third party damage insurance contracts: an 'occurrence' policy, or a 'claims made' policy. Second, pollution liabilities are ongoing problems that require a high level of technical skill to determine the condition of a property before it is insured. Many insurance carriers are still technically incompetent to assist insureds with the most basic pollution incident. A basic requirement for the survival of any new insurance program is profitability. The providers of EIL (Environmental Impairment Liability) insurance should not have to make apologies for achieving underwriting profits. More and more EIL insurers are recognizing the keys to providing quality EIL insurance services. The EPA's financial responsibility requirement for owners/operators of underground storage tanks will increase the available EIL options. (See also W91-05236) (Lantz-PTT)
W91-05238

IMPLICATIONS OF DEALING WITH REAL ESTATE-BASED CLEANUP STATUTES.
Nixon, Hargrave, Devans and Doyle, Albany, NY.
For primary bibliographic entry see Field 6E.
W91-05239

CURRENT ISSUES IN MANAGEMENT OF MOTOR FUEL CONTAMINATED SOILS.
American Petroleum Inst., Washington, DC.
B. Bauman.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 31-42, 2 fig, 3 tab, 7 ref.

Descriptors: *Water pollution prevention, *Oil pollution, *Soil contamination, *Path of pollutants, *Environmental protection, *Underground storage tanks, *Management planning, Site remediation, Oil industry, Regulations, Public health, Risk assessment.

Active Underground Storage Tank (UST) replacement programs of the major oil companies, initiated in advance of state and local regulations for USTs, are evidence that the industry recognizes its responsibility to provide the petroleum products our society requires (in excess of 400 million gallons of fuels alone each day), in a manner that minimizes the associated environmental risks. However, given the volume of activity, and the large number of sites where petroleum is stored, it is inevitable that some releases will occur. When they do it is important to respond in a manner that will provide a high level of protection for both human health and the environment. The industry also recognizes that the goals of corrective action programs should not be dominated by the need to remove or eliminate every single molecule of contamination as rapidly as can be arranged. Instead, the emphasis should be to manage affected sites in a manner that ensures the protection of water resources and eliminates unnecessary risks and exposures, but does not waste limited economic resources. (See also W91-05236) (Lantz-PTT)
W91-05240

EPRI-SPONSORED RESEARCH ON UNDERGROUND STORAGE TANKS.
Electric Power Research Inst., Palo Alto, CA. Coal Combustion Systems Div.
M. E. McLearn.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 43-47.

Descriptors: *Soil contamination, *Site remediation, *Water pollution control, *Research priorities, *Underground storage tanks, *Electrical industry, Fuel, *Oil pollution, Environmental protection, Leaking, Groundwater pollution, Environmental engineering, Utilities, Cleanup.

Underground storage tanks (UST) are used by the electric utility industry for a number of functions ranging from storage of motor vehicle fuel at service centers to storage of backup diesel fuel at power plants. While no accurate count has been made, it is estimated that the industry operates less than 2% of the UST in the country; this represents, however, more than 15,000 underground tanks. Almost all electric utility companies have some UST, and some have several hundred. In response to increasing concern about leaking tanks and potential resulting groundwater contamination, the electric utility industry has initiated a wide ranging research program to address the management of UST. Research on engineering options has focused on the important issue of remediation of contaminated soil and groundwater from UST leaks. Thirteen techniques, both in situ and non-in situ, were evaluated for application at UST sites. In addition to the engineering aspects (equipment, operation maintenance), institutional, environmental, and cost considerations in the application of each technique were explored. Electric utility companies are strongly motivated by economic considerations to minimize UST leaks. To aid utilities in the choice of options for UST management, EPRI has developed a decision support tool. The model, called TANKS, balances the known costs of leak prevention and mitigation against the uncertain cost of tank leaks using tank and on site-specific data to address key questions. (See also W91-05236) (Lantz-PTT)
W91-05241

UNDERGROUND STORAGE TANK RELEASES IN ARIZONA: CAUSES, EXTENT, AND REMEDIATION.
Arizona Dept. of Environmental Quality, Phoenix. Hydrology Section.
J. Haney.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 55-72, 13 fig, 3 tab, 4 ref.

Descriptors: *Water pollution sources, *Underground storage tanks, *Path of pollutants, *Arizona, *Environmental protection, *Site remediation, Environmental effects, Monitoring, Leaking, Databases, Fuel, Oil pollution, Groundwater pollution, Geohydrology.

The underground storage tank (UST) leak database was assessed to determine causes, extent, and remediation of UST leaks in Arizona. The majority of UST leaks in Arizona have occurred from product piping. UST leaks are primarily gasoline and diesel fuel, with lesser numbers of aviation gas, waste oil, and solvent leaks. The environmental impact of UST leaks depend on the geohydrologic setting. Approximately 26% of the UST leaks reviewed have affected groundwater quality, with approximately 1/3 of these requiring free product removal. The extent of contamination has been defined in all UST leak sites in Arizona demonstrating that: (1) the vertical extent of contamination usually far exceeds the horizontal extent, (2) clay and caliche layers do not halt the downward migration of product, and (3) the extent of contamination is often larger than would be predicted based on estimates of the amount of product lost. Since soil sample collection and analysis is problematic, a conservative approach which utilizes a sufficient number of soil samples is recommended. Also, standardization of soil sample collection and analysis procedures should be utilized. State UST program development is ongoing in both technical and regulatory areas. (See also W91-05236) (Lantz-PTT)
W91-05243

STATE OF RESEARCH AND REGULATORY APPROACH OF STATE AGENCIES FOR CLEANUP OF PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Environmental and Health Sciences Program.
C. E. Bell, P. T. Kostecki, and E. J. Calabrese.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 73-94, 4 tab, 5 ref.

Descriptors: *Water pollution prevention, *Research priorities, *Regulations, *Cleanup operations, *Soil contamination, *State jurisdiction, *Oil pollution, Public health, Standards, Path of pollutants.

Results from a recent survey suggest that state regulators are concerned about the problem of cleanup of petroleum contaminated soils (PCS) and its potential effect on public health and the environment. Most states have recently developed, or are in process of developing, standard operating procedures (SOPs), guidelines, and cleanup standards to address the PCS problem. States vary in the type of analytical methodologies applied to determine the extent of contamination, and often handle sites on a case by case basis. Few states have developed formal standards for cleanup; however many states have indicated a need for the development of formalized standards, as evidenced by the number of states applying informal cleanup levels to address the problem. Many states could benefit significantly from information collected by other states' research activities and experience, and through the implementation of alternative management strategies. Conventional treatment options such as excavating to landfills may be replaced in the future by new technologies specifically developed to deal with the PCS problem. (See also W91-05236) (Lantz-PTT)
W91-05244

FIELD-SCREENING TECHNIQUES: QUICK AND EFFECTIVE TOOLS FOR OPTIMIZING HAZARDOUS WASTE SITE INVESTIGATIONS.
Weston (Roy F.), Inc., Walnut Creek, CA.
L. M. Preslo, W. M. Leis, and R. Pavlick.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 111-117, 1 tab, 3 ref.

Descriptors: *Data acquisition, *Field tests, *Hazardous wastes, *Waste disposal, Monitoring, Analytical methods, Remote sensing, Site remediation.

Goals for site cleanup at hazardous waste sites can range from complete cleanup and site restoration of the environment, along with controlling off-site migration of contaminants to minimal actions devoted to monitoring only. Engineers require data with which to identify remedial alternatives, assess risks, compare these risks and alternatives against ideal situations and to each other, and to evaluate the costs that would be involved with site actions. The application of some available but lesser used field techniques to increase the efficiency of collecting necessary field data are proposed, such as: (1) Conducting a field program driven by the needs of the engineering design program; (2) Exhausting all available site data before collecting new site data; and (3) Conducting less intrusive studies which do not disturb the site. Remote sensing data and searches of site records will allow a fairly accurate assessment of site problems with an initial indication of possible remedial options. In addition to remote sensing and surface geophysics, on-site chemical analytic techniques are being used increasingly as field screening techniques. Field screening techniques provide information which streamlines data collection efforts by optimizing the use of intrusive techniques (soil boring and monitoring wells), and the number of samples sent to the laboratory for confirmatory chemical analysis. The ability to conduct site characterizations rapidly and provide necessary base-line data for remedial action engineering is enhanced by the use of less intrusive field techniques. Further, by conducting field studies in a support role to the remedial engineering, the efficiency of the total project operation is maintained and costs are minimized. (See also W91-05236) (Lantz-PTT)
W91-05246

ONSITE ANALYTICAL SCREENING OF GASOLINE CONTAMINATED MEDIA USING A JAR HEADSPACE PROCEDURE.
Massachusetts Dept. of Environmental Quality Engineering, Woburn. Div. of Hazardous Waste.
For primary bibliographic entry see Field 5A.
W91-05247

STABILIZED PETROLEUM WASTE INTERACTION WITH SILTY CLAY SUBGRADE.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
J. P. Martin, F. J. Biehl, and W. T. Robinson.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 177-197, 8 fig, 2 tab, 14 ref.

Descriptors: *Water pollution prevention, *Soil contamination, *Petroleum products, *Oil pollution, *Silt, *Clay, *Path of pollutants, *Waste disposal, Soil properties, Waste management, Hydrogen ion concentration, Hydrocarbons, Capillary conductivity, Infiltration, Groundwater movement, Geohydrology, Diffusion.

A technique has been developed to improve the on-site storage or disposal of hydrocarbon refining wastes that have little prospect of future reprocessing or feasibility for destructive (mineralization) treatment. The three basic controls on contaminant release from subsurface waste deposits or spill residuals are the: (1) prevention of mobility, (2) restriction of transport, and (3) control of potential gradients. Focus during the stabilization process itself is on the first two. The technique employed is to: recycle some of the wastes--the spent clay; and to mechanically, chemically, and hydraulically stabilize the other waste--acid hydrocarbon sludge. It is also necessary to control the pH and provide a pozzolanic cementing for the clay structure. The result is not unlike the entrapment of hydrocarbons in an adsorptive, very fine grained matrix--a microencapsulation. Movement from such a condition is restricted, but is certainly possible. A number of potential mechanisms of dissolved contaminant transport were identified. Four involved hydraulic gradients (capillary and consolidation drainage, and infiltration and groundwater seepage). Capillary and consolidation drainage are expected to be important only during the first few years after deposition, while the risk of groundwater contamination is a key long-term threat. Another mechanism of release is molecular diffusion which can only be limited indirectly, by emphasizing contaminant fixation and liner thickening to reduce the concentration gradient. It was also demonstrated that the liner displayed significant capacity for development for contaminant attenuation as well as providing a reasonably stable hydraulic barrier. (See also W91-05236) (Lantz-PTT)
W91-05251

ENHANCED BIOREMEDIATION TECHNIQUES FOR IN SITU AND ONSITE TREATMENT OF PETROLEUM CONTAMINATED SOILS AND GROUNDWATER.
C.A.A. Bioremediation Systems, Boston, MA.
S. Fogel, M. Findlay, and A. Moore.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 201-209, 5

fig, 1 ref.

Descriptors: *Water pollution treatment, *Site remediation, *Bioremediation, *In situ treatment, On-site investigation, Petroleum production, *Oil pollution, *Groundwater pollution, *Soil contamination, *Biodegradation, Cleanup operations, Monitoring, Organic compounds, Soil bacteria, Oxygen, Nutrients, Hydrocarbons, Biological treatment.

Bioremediation is a process by which organic contaminants are destroyed by the action of soil bacteria. Since the constituents of petroleum products are naturally occurring chemicals, soil bacteria capable of degrading them are relatively ubiquitous. Bioremediation can be carried out in situ for saturated soils located below the water table. Unsaturated soils can also be treated in situ or on-site. The same principles are involved, but the methods of delivering oxygen and mineral nutrients differ. Biodegradation in place is a faster and less costly method for the treatment of contaminated soil below the water table. In this approach, the oxygen and mineral nutrients are delivered to the contaminated area so that the bacteria can degrade the dissolved, adsorbed and trapped hydrocarbons in place. The delivery of the nutrients is accomplished by dissolving them in groundwater that is recirculated through the contaminated area and reinjected up-gradient using wells or trenches. Soil which is contaminated by petroleum hydrocarbons may be excavated from a spill site, either to prevent further contamination of underlying strata or to permit excavation of a leaking tank. Such soil has traditionally been hauled to a disposal site and replaced with clean backfill. Recently, the cost of soil disposal has risen sharply, making biological treatment a cost effective alternative. Furthermore, biological treatment results in the destruction of the contamination and the elimination of future liability. (See also W91-05236) (Lantz-PTT)
W91-05252

BIODEGRADATION OF DISSOLVED AROMATIC HYDROCARBONS IN GASOLINE-CONTAMINATED GROUNDWATERS USING DENITRIFICATION.
San Diego State Univ., CA. Graduate School of Public Health.
R. M. Gersberg, W. J. Dawsey, and H. F. Ridgeway.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 211-217, 2 fig, 3 tab, 8 ref.

Descriptors: *Water pollution treatment, *Biodegradation, *Aromatic compounds, *Hydrocarbons, *Groundwater pollution, *Denitrification, *Cleanup operations, Biological treatment, Hydrogen peroxide, Aquifers, Microbial degradation, Benzenes, Toluene, Xylenes, Organic compounds, Nitrates.

The biodegradation of benzene, toluene, and xylene (BTX) in gasoline-contaminated groundwater was investigated in the laboratory both aerobically (using hydrogen peroxide) and also under anoxic conditions with nitrate serving as the principal electron acceptor. Aerobic loss rates for monoaromatics can be very rapid when peroxide distribution (and subsequent breakdown to O2) is uniform. The difficulty of distributing H2O2 uniformly throughout an aquifer and also controlling its decomposition in the subsurface environment makes an extrapolation of experimental laboratory data results to actual field-scale situation, problematic. Data presented show that the microorganisms in groundwaters have the ability to degrade BTX under anoxic (denitrifying) as well as aerobic conditions. The ability of phosphorus to enhance such activity is demonstrated. Rates of BTX loss under denitrifying conditions are high enough to suggest that the addition of nitrate to BTX-contaminated groundwaters may prove to be a cost-effective alternative to conventional aerobic processes for the bioremediation of aquifers contaminated with monoaromatic hydrocarbons. (See also W91-05236) (Lantz-PTT)
W91-05253

BIOREMEDIATION OF PETROLEUM CONTAMINATED SOILS USING A MICROBIAL CONSORTIA AS INOCULUM.
Solmar Corp., Orange, CA.
B. A. Molnaa, and R. B. Grubbs.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 219-232, 4 fig, 2 tab, 14 ref.

Descriptors: *Site remediation, *Water pollutio treatment, *Bioremediation, *Petroleum products, *Soil contamination, *Microbial degradation, *Cleanup operations, Waste disposal, Oil pollution, Hydrocarbons, Biological treatment, *Biodegradation, California.

Several innovative and successful bioremediation programs have been conducted in conjunction with various environmental engineering firms and remediation contractors. Bioremediation was selected to clean up an abandoned refinery site in southern California. The initial contamination site ranged from a low of 1,500 ppm to a high of 30,000 ppm. The site was sectioned off into several treatment zones and a bioremediation was begun. The treatment was conducted over a period of 6 months and the entire area was certified as cleaned within one year. The City of Carson condemned a site that had been used as a petrochemical tank storage tank and salvage operation. A bioaugmentation program was elected to clean up the site. The cost of the cleanup was less than $132,000. The price for hauling away the contaminated soil for proper disposal was estimated to have been 2 million dollars--a considerable savings. Bioremediation was the method of treatment opted for, to treat 1500 cu yd of diesel-contaminated soil at the former King's Truck Stop in Sacramento, California. The project reduced the diesel contaminated levels from 3000 ppm to < 30 ppm in approximately 62 treatment days. Similar cases are presented showing the cost effectiveness and reliability of bioremediation are presented. (See also W91-05236) (Lantz-PTT)
W91-05254

CUTOFF WALLS TO CONTAIN PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-05255

THERMAL DESORPTION OF HAZARDOUS AND TOXIC ORGANIC COMPOUNDS FROM SOIL MATRICES.
C. P. Varuntanya, M. Hornsby, A. Chemburkar, and J. W. Bozzelli.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 251-265, 12 fig, 6 tab, 11 ref.

Descriptors: *Superfund, *Cleanup operations, *Hazardous wastes, *Organic compounds, *Soil contamination, Thermal properties, Dioxin, Chlorinated hydrocarbons, *Site remediation, Incineration.

Thermal desorption of soil matrices contaminated with organic compounds (compounds such as chlorinated dioxins not yet tested) is the method of choice when considering remediation of hazardous waste sites. Moderate desorption over temperatures, in the vicinity of the boiling point of the target compound, can be suitable for reducing concentrations to acceptable levels. The moderate temperature requirements can be equated to moderate energy inputs and costs. Cost is a major criteria in the selection of a remedial technology. Modified conventional equipment such as rotary kilns, asphalt kilns, or incinerators operated at lower than normal temperatures may be used in scaled up operations. This will serve to further lower costs. Thermal desorption also satisfies two EPA policies established in the 1986 Superfund Amendments and Reauthorization Act (SARA): on-site treatment and permanent solutions. The thermal desorption system could be portable and transported to a site, then removed when the soil has been processed. Desorption can be a part of a permanent solution. Once the vapors have been desorbed, they could be incinerated in an afterburner, thus reducing long-term risks and liabilities. (See also W91-05236) (Lantz-PTT)
W91-05256

HOT MIX ASPHALT TECHNOLOGY AND THE CLEANING OF CONTAMINATED SOIL.
Brox (George), Inc., Dracut, MA.
R. C. Czarnecki.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 267-277, 5 fig, 3 tab.

Descriptors: *Soil contamination, *Cleanup operations, *Site remediation, *Hot mix asphalt, *Incineration, Soil treatment, Soil properties, Particle size, Clay, Sand.

Processing contaminated soil in a Hot Mix Asphalt (HMA) facility has many advantages: (1) The incineration technology required is related to HMA technology, (2) Capital investment is in place with only modifications required; (3) Decontaminated soil can be incorporated into HMA; (4) Small quantities of soil can be processed economically (large quantities or continuous runs are not necessary); (5) With over 5000 HMA plants, a plant should be near the product, and thereby lower freight costs, and (6) No continuing liability for the generator. Not all soils are suitable for recycling into HMA, owing to clay content and particle size. High clay content is objectional because it reduces the overall strength of HMA. Soils with high content (20%) of any minus 200 mesh material may also deteriorate when incorporated into HMA by contributing to potential stripping problems. An average HMA composition contains 60% coarse aggregate, 40% fine aggregate (sand), and 5.5% liquid asphalt. The total acceptable minus 200 mesh material in the end product is approximately 6%. (See also W91-05236) (Lantz-PTT)
W91-05257

REMOVING PETROLEUM PRODUCTS FROM SOILS WITH OZONE, ULTRAVIOLET, ULTRASONICS, AND ULTRAPURE WATER.
Excalibur Enterprises, Inc., New York.
L. Boeve.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 279-282, 2 fig.

Descriptors: *Water pollution treatment, *Petroleum products, *Soil contamination, *Cleanup operations, *Ozone, *Ultraviolet radiation, *Ultrasonics, *Ultrapure water, *Site remediation, Chemical treatment, Organic compounds, Polychlorinated biphenyls, Phenols, Benzene, Cyanide.

An effective and economical system has been developed to purify air, water, and inert materials, including soils and sediments. The OUUU process utilizes ozone, ultraviolet, ultrasonics, and ultrapure water to remove and destroy contaminants. The OUUU process is a two stage system in which the contaminants are first removed from the soil with ultrapure water as the solvent, and then the aqueous solution is treated to convert the contaminants into CO2, H2O and harmless salts. The process requires no incineration, landfilling or chemicals, is portable, and can be operated on-site. The OUUU process has been used to remove a number of organic contaminants including polychlorinated biphenyls (PCBs), pentachlorophenols (PCPs), 2,4,5-trichlorophenols (TCPs), benzene and cyanide from water and inert materials such as wood, paper, metals, and resins. The size of the systems ranged from one cubic foot per hour of inert material with a water flow rate of one gallon per minute, to 27 cubic yards per hour with a water flow rate of 50 gal/min. (See also W91-05236) (Lantz-PTT)

W91-05258

CLEANUP OF A GASOLINE CONTAMINATED SITE USING VACUUM EXTRACTION TECHNOLOGY.
Terra Vac, Inc., Princeton, NJ.
J. J. Malot.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 283-301, 8 fig, 5 tab, 3 ref.

Descriptors: *Groundwater pollution, *Water pollution treatment, Vadose zone, Leakage, Pipelines, *Cleanup operations, *Gasoline, *Vacuum extraction, Petroleum products, *Site remediation, Hydrocarbons, Benzenes, Toluene, Xylenes, Organic compounds.

Based on the results of a pilot test, The Terra Vac Vacuum Extraction Process has been found to be effective in cleaning up the residual hydrocarbons beneath the Belleview site in Florida, where residents complained that water the municipal well field had an objectionable taste and odor. Testing of subsoils indicated elevated levels of gasoline hydrocarbons above a clay layer occurring at depths of 15 to 20 ft that are spread at least 50 feet from the source area of a leaky pipeline. In addition, high levels of benzene, toluene, and xylenes (BTX) were observed near the water table. Rates of extraction of hydrocarbons from the subsoils using the vacuum extraction process reached a maximum of 2000 lb/day. More than 22,000 lb (2750 gal) of gasoline hydrocarbons were recovered during the pilot test and subsequent vacuum extraction operations. As a result of vacuum extraction operations, hydrocarbon concentrations in the groundwater aquifer have been reduced significantly. The vacuum process operated a total of 150 days over a period of seven months and achieved significant reductions of hydrocarbons within the vadose zone. Soil concentrations were reduced from initial levels of about 30 ppm to levels ranging from less than 1 ppm benzene. Comparison with cleanup objectives for the site indicated that within the radius of influence of the vacuum system, soil decontamination had been achieved. (See also W91-05236) (Lantz-PTT)
W91-05259

USING SOIL VAPOR CONTAMINANT ASSESSMENT AT HYDROCARBON CONTAMINATED SITES.
EA Engineering, Science, and Technology, Inc., Symrna, GA.
For primary bibliographic entry see Field 5B.
W91-05260

ASSESSMENT AND REMEDIATION OF RESIDENTIAL PROPERTIES CONTAMINATED WITH HOME HEATING OIL: CASE STUDIES.
Haley and Aldrich, Inc., Cambridge, MA.
R. W. Wilhelm, and R. J. Bouchard.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 329-346, 2 fig, 3 tab.

Descriptors: *Risk assessment, *Site remediation, *Oil pollution, *Case studies, *Path of pollutants, *Soil contamination, Leakage, Storage tanks, Cleanup operations, Costs, Economic aspects, Regulations, Standards, Public policy, Insurance, Groundwater pollution, Massachusetts.

Three case studies are presented which exhibit some of the complexities encountered when faced with the restoration of a residential property following a release of home heating oil. Some of the problems addressed relative to cleanup are: (1) Physical constraints--relatively small work areas often limited by the living space itself, (2) Costs of investigations and remedial work--completely borne by the homeowner, and limited through property value or limits set by the insurance policy, (3) Time--the time needed to temporarily relocate families while restoration takes place, and for dealing with adverse weather conditions, (4) Regulatory Involvement--the imposition of standards and policies designed for larger commercial and industrial sites. Another problem which must be dealt with is the homeowner's insurance policy. A typical policy excludes environmental impairment, and is restricted to replacement value of the structure and contents, and not the resultant contaminated soil or groundwater beneath it. In the three cases reviewed, each residence possessed an above ground tank. The potential for leaks and spills in this situation is usually due to sudden and accidental causes, as opposed to the gradual loss of product typically associated with underground storage tanks. Preferred engineering options for the restoration of the residential property versus the undesirable alternative of demolition, are reviewed relative to the magnitude of the fuel oil released under the structure. The assessment techniques and remedial actions presented were performed at residential properties located in contrasting geohydrologic and urban settings in southeastern Massachusetts. (See also W91-05236) (Lantz-PTT)
W91-05262

OVERVIEW AND SUGGESTED METHODOLOGY TO DETERMINE THE ADEQUACY OF CLEANUP OF CONTAMINATED SOILS.
Environmental Protection Systems, Inc., Fairlawn, NJ.
F. N. Rubel, B. J. Burgher, and E. C. McGriff.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 409-416, 4 fig, 1 tab, 14 ref.

Descriptors: *Cleanup operations, *Soil contamination, *Performance evaluation, *Oil pollution, *Management planning, Petroleum products, Polycyclic aromatic hydrocarbons, Standards, Regulations.

Guideposts exist for selecting the level of cleanup of oil contaminated soils; with few exceptions this remains a case by case determination. The use of comparative data on the presence of oil and its constituents in the environment should be considered in setting any firm standard or site-specific cleanup level. An environmentally important component of oil is the class of compounds identified as polynuclear aromatic hydrocarbons. They include carcinogens, and therefore represent a significant subset of data to focus on when setting a desired cleanup level for petroleum contaminated soil. Regulatory agencies should establish an agreed-upon risk assessment model for oil contaminated soils. To date, a conceptual hierarchy of cleanup criteria, in the shape of a pyramid, based on the concentration of oil in the soil, has been developed. The highest concentration (the base of the hierarchy of cleanup) will lend itself to visual criteria, while the lowest concentration (at the peak) will be subject to health risk criteria. (See also W91-05236) (Lantz-PTT)
W91-05263

TOWARD ECONOMICALLY EFFICIENT MANAGEMENT OF UNDERGROUND STORAGE TANKS: A RISK-BASED APPROACH.
Little (Arthur D.), Inc., Cambridge, MA.
B. H. Metzger.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 417-450, 14 fig, 7 tab, 16 ref.

Descriptors: *Water pollution prevention, *Groundwater pollution, *Economic aspects, *Underground storage tanks, Risk assessment, Classification, Costs, Model studies.

Algorithms were developed for rapid, sufficiently accurate, and inexpensive classification, assessment and ranking of underground storage tanks (UST) sites, with a conceptual framework for identifying the best groundwater protective action for any given site. These algorithms have not been tested yet under field conditions, and the mechanism for prescribing action has to be fully developed and calibrated using field data. Therefore a number of tasks have been identified and proposed which warrant further work before a risk-based policy can be formulated. There may be 500,000 UST sites in the US (23,000 in Illinois) with an average age of over 14 years. Most of the tanks are of unprotected bare steel construction and, according to national statistics, 10% or more may be leaking at this time. A large fraction of them are installed in urban areas, posing safety threats and fire and explosion hazards, and affecting environment and land values. The US EPA favors a uniform technical standard for all UST sites, regardless of site risk. The agency, in an economic model, assumes corrective action costs never to exceed $388,000 at any site. This contradicts empirical evidence which suggests that in 5% to 10% of sites, corrective action can cost $1 million. (See also W91-05236) (Lantz-PTT)
W91-05264

CALIFORNIA LEAKING UNDERGROUND FUEL TANK FIELD MANUAL: A GUIDANCE DOCUMENT FOR ASSESSMENT OF UNDERGROUND FUEL LEAKS.
Orange County Health Care Agency, Santa Ana, CA.
S. J. Daugherty.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 453-469, 2 fig, 7 tab, 8 ref.

Descriptors: *California, *Water pollution sources, *Manuals, *Underground storage tanks, *Data interpretation, *Path of pollutants, *Soil contamination, Petroleum products, Groundwater pollution, Risk assessment.

An effort to develop more consistent, systematic, and defensible procedures to assess the significance of soil contamination from underground fuel tanks, and its relationship to potential groundwater pollution, was initiated in California in October 1985. A result of this is the California Leaking Underground Fuel Tank (LUFT) Field Manual. The LUFT Field Manual procedures are directed toward site specific risk assessment and risk management. The manual is a nonmandated, nonexclusive technical guidance tool that uses a stepwise screening procedure to assess sites for regulatory purposes. LUFT procedures are applicable only to contamination from underground fuel tanks and focus on the ingestion (via groundwater) exposure pathway. The methodology is limited to gasoline and diesel fuel, and develops procedures that result in numerical cleanup levels. From a local agency viewpoint, the LUFT document can be considered an attempt to better define 'significant soil contamination'. (See also W91-05236) (Lantz-PTT)
W91-05265

LETTING THE SLEEPING DOG LIE: A CASE STUDY IN THE NO-ACTION REMEDIATION ALTERNATIVE FOR PETROLEUM CONTAMINATED SOILS.
Bank of America Environmental Services, Orange, CA.
E. C. Henry, and M. E. F. Hansen.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 471-483, 4 fig, 2 tab, 5 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Case studies, *Site remediation, *Soil contaminationo, *Petroleum products, Cleanup operations, Geohydrology, Soil properties, Underground storage tanks, Waste disposal, Hydrocarbons, Oil pollution, Path of pollutants.

In selected circumstances where geological and hydrological conditions are favorable, a 'no action remediation' may be considered the appropriate alternative to the cleanup of petroleum contaminated soils. A case study presents the rationale for leaving some petroleum contaminated soil in place

and untreated, based on the understanding of site conditions and potential impacts as drawn from environmental investigations performed at the site. Three 8,000 gallon steel tanks were excavated. During removal it was observed that the tank backfill soils exhibited a strong gasoline odor. Soils were removed and stockpiled. Fuel hydrocarbons in the soils appeared to be from spilling during overfillage. Six soil samples were retained and analyzed and the presence of hydrocarbons was detected. A fate and transport study was undertaken to estimate the history of the hydrocarbons over time if left in place. The hydrocarbons which remain in the soils are expected to biodegrade over time by naturally bacterial metabolism. Since hydrocarbons occur within the unsaturated zone well above the water table, they will be subject to long-term aerobic conditions and are expected to diminish in concentration over time. (See also W91-05236) (Lantz-PTT)
W91-05266

COUNCIL FOR HEALTH AND ENVIRONMENTAL SAFETY OF SOILS (CHESS): A COALITION TO STANDARDIZE APPROACHES TO SOIL CONTAMINATION PROBLEMS.
Massachusetts Univ., Amherst. Environmental and Health Sciences Program.
P. T. Kostecki, and E. J. Calabrese.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 485-495, 4 fig.

Descriptors: *Soil contamination, *Council for Health and Environmental Safety of Soils, *Institutions, Standards, Risk assessment, *Site remediation, Information exchange, Decision making.

The International Society of Regulatory Toxicology and Pharmacology created for the Council for Health and Environmental Safety of Soils--CHESS has as its goal a leadership role in soil contamination issues through: (1) providing consensus guidelines on analytical techniques, risk assessment methodologies, and remediation of contaminated soils; (2) conducting scientific evaluations and analyses and providing recommendations; (3) providing technical information transfer; (4) providing education and training functions; (5) enhancing dialog among affected groups. The ultimate product of CHESS will be comprehensive decision methodology (tree) which will be applicable to all types of soil contamination sites. The methodology will include a decision making frame work for site specific considerations from initial analyses to final corrective action. (See also W91-05236) (Lantz-PTT)
W91-05267

EFFECTS OF ALUM TREATMENT ON PHOSPHORUS DYNAMICS AND PHYTOPLANKTON RESPONSE IN EAU GALLE RESERVOIR, WISCONSIN.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
J. W. Barko, W. F. James, W. D. Taylor, and D. G. McFarland.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report E-90-1, September 1990. Final Report. 44p, 11 fig, 4 tab, 67 ref, append.

Descriptors: *Water pollution treatment, *Lake restoration, *Alum, *Eau Galle Reservoir, *Phosphorus, *Phytoplankton, *Ecological effects, *Limnology, Wisconsin, Water quality, Aluminum sulfate, Ecosystems, Productivity, Water chemistry, Nutrients, Hypolimnion, Cyanophyta.

The hypolimnion of Eau Galle Reservoir, Wisconsin, was treated with aluminum sulfate (alum) in 1986 to reduce excessive phytoplankton production associated with high phosphorus loading from anoxic, profundal sediments. Prior to treatment, internal total phosphorus (TP) loading was 3 to 6 times greater than external TP loading during summer stratification. Periodic increases in epilimnetic TP mass and chlorophyll-a concentrations closely corresponded with elevated internal TP. For 1 year following treatment, internal TP loading and concentrations of soluble reactive phosphorus in the hypolimnion were substantially reduced. Abnormally high TP loading during the stratified period of 1986 sustained high TP mass and chlorophyll in the epilimnion. During the summer of 1987, effects of alum treatment on internal TP loading were essentially negated, as epilimnetic TP mass and chlorophyll remained unchanged from pretreatment years. Following alum treatment in 1986, phytoplankton biomass was less than half that occurring during the previous year; however, it was not significantly different from other years. Subsequent to several years of codominance with blue-green algae, the dinoflagellate Ceratium hirundinella assumed singular dominance in 1985. With the exception of change in relative dominance (maintained through 1988), the phytoplankton community of the Eau Galle Reservoir has been remarkably stable, despite effects of winter drawdown in 1984, alum treatment in 1986, and climatic (wet versus dry) extremes over the 8-year study period. Without a decrease in phosphorus availability, Ceratium and blue-green algae are likely to persist as codominants during the summer in this system for many years. (Author's abstract)
W91-05271

TRANSLATING RESEARCH INTO PRACTICE: THE DRINKING WATER INDUSTRY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W91-05279

CONTINUOUS WATER QUALITY MONITORING.
South Africa Dept. of Water Affairs, Pretoria. Water Pollution Control Directorate.
P. Van Eeden, and H. Myburgh.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 46-47.

Descriptors: *Water pollution control, *Water sampling, *Measuring instruments, Conductivity, Temperature, Control systems, Data acquisition, *South Africa, *Monitoring, *Automation, Water quality control, Probes.

The need for a more rigorous method of control of the quality of the scarce water sources in the Republic of South Africa, prompted the Pollution Control Directorate of the Department of Water Affairs to explore alternate strategies to the conventional 'grab' sampling technique. A prototype for a discrete data logger capable of capturing conductivity and temperature data was installed in the Hartbeespoort Dam catchment in December 1981. Each unit consisted of a probe in the stream connected by electric cable to a display unit and battery, in turn connected to a micro-processor (memory) controlling the system and capturing data every 30 minutes onto an EPROM (erasable programmable read only memory). The reliability is around 95% (over a period of 4 years) and error is around 10% (once the probe has been stabilized in the river system). The major cost factor to obtain one reading is incurred in the form of travelling expenses. Equipment depreciation and battery replacement is minor. Based on the network being operated, the cost per reading is under 1c. Distant stations using their own field staff, and posting the EPROM's to the Department's central data processing facility, operate well within this figure. (See also W91-05281) (White-Reimer-PTT)
W91-05287

WATER CONTENT-DENSITY CRITERIA FOR COMPACTED SOIL LINERS.
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W91-05379

ECONOMIC DECISION-MAKING FRAMEWORK FOR ANALYZING ATMOSPHERIC DEPOSITION IMPACTS IN EASTERN U.S. FORESTS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Forestry.
For primary bibliographic entry see Field 6B.
W91-05387

MICROBIAL TRANSFORMATION OF 1,2-DIBROMO-3-CHLOROPROPANE (DBCP).
Cornell Univ., Ithaca, NY. Inst. for Comparative and Environmental Toxicology.
R. A. Bloom, and M. Alexander.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 4, p 722-726, Oct-Dec 1990. 3 fig, 2 tab, 24 ref. NIH Public Health Service training grant ES-07052.

Descriptors: *Biodegradation, *Biological treatment, *Bioremediation, *Fate of pollutants, *Microbial degradation, *Pesticides, *Pseudomonas, *Water pollution treatment, Culturing techniques, Detoxification, Groundwater pollution, Pesticides residues, Soil contamination.

A once widely used nematicide that is now banned, 1,2-dibromo-3-chloropropane (DBCP), persists in groundwaters and is a significant pollutant in some water supplies. A study was conducted to determine whether a means for the biodegradation of this persistent compound could be devised. DBCP was not converted to organic products, halide, or CO2 in unamended samples of soil, subsoil, subsoil material, or groundwaters in 60 d, and no microorganism could be isolated that was able to use the compound as a C source for growth. However, cell suspensions of Pseudomonas putida and of bacteria grown in solutions containing chlorinated fatty acids or 3-chloro-1-propanol cometabolized DBCP in the presence of O2 with the formation of halide but not CO2. Pseudomonas putida had the greatest activity. DBCP was also converted aerobically to organic products and CO2 by soil suspensions incubated with methane. The compound was also converted anaerobically to organic products but not CO2 in suspensions of soil, but no anaerobic transformation was observed in samples of groundwater or aquifer solids. These results suggest that biological treatment may be used as a means to destroy this pollutant. (Author's abstract)
W91-05403

ASPECTS OF TRANSPORT PROCESSES IN AGGREGATED SOILS.
Silsoe Coll. (England).
For primary bibliographic entry see Field 5B.
W91-05473

MEASUREMENT OF OPERATOR TRAINING BENEFITS.
California State Univ., Sacramento. Dept. of Civil Engineering.
K. D. Kerri.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1811-1816, 1991. 3 fig, 1 tab, 3 ref.

Descriptors: *Cost-benefit analysis, *Personnel management, *Training, *Wastewater facilities, *Wastewater treatment, Education, Employee training, Facility operation, Operating policies, Public relations.

Training programs can be very helpful in assisting operators to prepare for and pass operator certification examinations. Operators in a training program perform at a much higher level than operators without the benefit of a training program. Benefits from operator training programs need to be measured to justify training budgets. Training benefits can be measured by both quantitative and qualitative procedures. Actual benefits from operator training programs can be measured in terms of money saved on plant operation and maintenance, improved operator performance on certification examinations, better quality plant effluents, achievement of optimum chemical dose and favorable impressions on regulatory agency personnel. Benefits from training also affect public satisfaction, public image, protection of capital invest-

ment, compliance with regulations, safety, staff selection and promotion and operator self-esteem. However, trainers need to identify the objectives of a training program before they can develop means of measuring benefits. Wastewater treatment plant operators can be expected to be able to: protect the environment from inadequately treated wastewater; keep accurate records; maintain equipment; adjust and calibrate controls; read meters; repair and replace broken pipes; perform calculations related to tank volumes and waste loadings; order parts and tools; collect samples and perform laboratory tests; conduct safety inspections; prepare written reports; and pass operator certification or licensing exams. (Mertz-PTT)
W91-05508

EFFECT OF STRIP BED ROUGHNESS ON THE REAERATION RATE COEFFICIENT.
Sao Paulo Univ., Sao Carlos (Brazil). Dept. de Hidraulica e Saneamento.
J. R. Bicudo, and M. F. Giorgetti.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1929-1939, 1991. 7 fig, 2 tab, 19 ref. Fundacao de Amparo a Pesquisa do Estado de Sao Paulo grants 88/2118-5 and 89/0037-0.

Descriptors: *Dissolved oxygen, *Instream aeration, *Receiving waters, *Wastewater disposal, *Water pollution treatment, Biodegradation, Biological oxygen demand, Organic wastes, Oxygen, Reaeration coefficient.

Stream reaeration is the physical absorption of oxygen from the atmosphere by a flowing stream. This is recognized as the main process by which a stream replenishes the oxygen consumed during biodegradation of organic wastes. The primary use of reaeration rate coefficients is in the quantification of river recovery processes by dissolved oxygen-biological oxygen demand water quality models. The reaeration coefficient must be known accurately if the dissolved oxygen resources of the stream are to be properly managed. Measurements were taken for the rate of atmospheric reaeration in open-channel flow under different conditions of depth and bed roughness. A 2 to the k factorial design was employed for the estimation of both depth and bed resistance factor effects upon stream reaeration. Consistent results indicated that stream reaeration is primarily controlled by water shear, but that different modes of instability generated by a combination of depth and strip roughness levels might prevail for different boundary roughness conditions, and as a consequence, differently affect the reaeration coefficient. (Mertz-PTT)
W91-05521

ANALYSIS OF DEWATERING CHARACTERISTICS OF LAKE AND RIVER SEDIMENTS.
National Chemical Lab. for Industry, Yatabe (Japan).
S. Tokunaga.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 1969-1978, 1991. 12 fig, 1 tab, 5 ref.

Descriptors: *Drying, *Lake sediments, *Organic pollutants, *River sediments, *Sediment analysis, *Sedimentation rates, *Water pollution treatment, Dewatering, Dredging, Sediment contamination, Sediments, Water pollution, Water quality control.

The water quality of enclosed water areas such as lakes, bays, and inland seas is strongly affected by the sediments on the bottom containing large amounts of pollutants. At present, seriously polluted sediments are removed from the water area mainly by dredging operations. The dredged sediments are usually transported to an adjacent reclamation area and allowed to stand, in order to reduce the volume of the sediment mainly by gravity settling. It is usually very difficult to remove water from sediments since they strongly hold water. In order to analyze the dewatering characteristics of sediments, settling and filtration tests were made on 25 types of freshwater lake and river sediments. Relationships among the indexes of the dewatering characteristics and effects of particle size and ignition loss on the dewatering characteristics were analyzed. A linear correlation existed between the initial settling rate and the compression volume. Particle size showed linear correlations to the initial settling rate, compression volume, and water content of filter cake, indicating that sediments of fine particles were difficult to be dewatered. Existence of organic pollutants strongly reduced the efficiency of gravity settling. By the addition of NaCl, the initial settling rates decreased down to 56% and the specific resistances decreased down to 35% of the NaCl-free sediments. (Mertz-PTT)
W91-05525

FATE OF MEVINPHOS SPILL AND WATER QUALITY: A CASE STUDY FROM LAKES PEN MUNICIPAL DUMP.
Underground Water Authority, Kingston (Jamaica).
For primary bibliographic entry see Field 5B.
W91-05659

USEPA POLLUTION PREVENTION RESEARCH PROGRAM.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
H. M. Freeman.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 167-177.

Descriptors: *Administrative agencies, *Environmental protection, *Federal jurisdiction, *Metal-finishing wastes, *Water pollution control, *Water quality management, Air pollution control, Environmental Protection Agency, Industrial wastes, Local governments, Recycling, Research priorities, Waste management, Waste reduction, Water pollution prevention.

The U.S. EPA pollution prevention program being carried out by the Office of Research and Development was discussed. Six fundamental goals of the program were identified: (1) Stimulate the development and use of products that result in reduced pollution; (2) Stimulate the development and implementation of technologies and processes that result in reduced pollution; (3) Expand the reusability and recyclability of wastes and products and the demand for recycled products; (4) Identify and promote the implementation of effective non-technological approaches to pollution prevention; (5) Establish a program of research that will anticipate and address future environmental problems and pollution prevention opportunities; and (6) Conduct a vigorous technology transfer and technical assistance program. In fiscal year 1989, several major, largely extramural programs were established within the Pollution Prevention Research Branch. The Waste Reduction Innovative Technology Evaluation Program (WRITE) was designed to identify, evaluate, and/or demonstrate the use of innovative engineering and scientific technologies to reduce the volume and/or toxicity of wastes. The WRITE Program has three subprograms: The WRITE Pilot Program with State and Local Governments; the WRITE Program with Industry; and the WRITE Research Program. The Waste Reduction Evaluations at Federal Sites Program (WREAFS) consists of a series of demonstration and evaluation cooperative projects between USEPA and other federal agencies. The Waste Reduction Assessments Program (WRAP) encourages the industrial and commercial sector to actively seek out opportunities to reduce the generation of wastes. Other programs include the USEPA's Pollution Prevention Information Clearinghouse (PPIC) and the Waste Reduction Institute for Scientists and Engineers (WRISE) established in cooperation with the University of Cincinnati. A list of sources to contact for more information is included. (See also W91-05668) (MacKeen-PTT)
W91-05669

DHS WASTE REDUCTION PROGRAM.
California Dept. of Health Services, Sacramento. Toxic Substances Control Div.
K. Wilhelm, P. Hadley, D. Hartley, and R. McCormick.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 178-183.

Descriptors: *Administrative agencies, *California, *Environmental protection, *Metal-finishing wastes, *Recycling, *Waste reduction, *Water pollution control, Air pollution control, Industrial wastes, State governments, Waste management, Water pollution prevention, Water quality management.

The Waste Reduction Program of California is located in the Alternative Technology Section, Toxic Substances Control Division, Department of Health Services (DHS). The program comprises three units: the Waste Reduction Unit; the Resource Recovery Unit; and the Technology Clearinghouse Unit. The major activities undertaken by the Waste Reduction Unit include managing the Department's Hazardous Waste Reduction Grants Program and contracting for waste audit studies to assist California's smaller businesses in reducing their hazardous wastes. The Resource Recovery Unit has as its primary focus the promotion of recycling, reuse and recovery of resources that might otherwise be lost to land disposal. The objective of the Technology Clearinghouse Unit is to provide a focal point for the generation and dissemination of technical information on hazardous waste reduction, recycling and treatment technologies and strategies. Increasingly more stringent regulations, escalating treatment and disposal costs, and industry trends may be the major impetus for industries to minimize waste. (See also W91-05668) (MacKeen-PTT)
W91-05670

DEVELOPING THE WASTE REDUCTION ASSESSMENT MANUAL (WRAM): AN AID TO WASTE REDUCTION.
California Dept. of Health Services, Sacramento. Alternative Technology Section.
D. Q. Garza.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 184-188. 1 tab, 2 ref.

Descriptors: *California, *Handbooks, *Hazardous wastes, *Industrial wastes, *Metal-finishing wastes, *Waste reduction, *Water pollution control, Assessments, Economic evaluation, Recycling, Waste management, Water pollution prevention, Water quality management.

A Waste Reduction Assessment Manual (WRAM) was developed by the California Department of Health Services. The WRAM is intended to give medium and small shops a tool for evaluating their operations from a waste reduction perspective. The checklist is organized into a format that provides descriptions of the waste reduction options and explanations of the benefits of each option. The manual gives a simple procedure for evaluating and prioritizing the options which can be modified to fit the operations of a particular shop. A simple worksheet is included to allow a rough estimate of the costs, savings and payback period of a waste reduction option. It is concluded that using WRAMs can help small quantity generators reduce the amount of hazardous waste they produce. (See also W91-05668) (MacKeen-PTT)
W91-05671

CALIFORNIA LAND BAN OF METAL-CONTAINING AQUEOUS WASTES.
California Dept. of Health Services, Sacramento. Alternative Technology Section.
B. W. Lee.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 189-203. 1 fig, 4 tab, 38 ref.

Descriptors: *California, *Hazardous wastes, *Land disposal, *Metal-finishing wastes, *Metals, *Regulations, *Wastewater treatment, *Water pollution control, Administrative agencies, Chemical wastewater treatment, Chromium, Industrial wastewater, Legislation, Standards.

The Hazardous Waste Management Act of 1986 requires the Department of Health Services to prohibit, by May 8, 1990, the land disposal of untreated hazardous wastes, and to adopt treatment standards establishing the level of treatment required prior to land disposal. Since the federal Resource Conservation and Recovery Act (RCRA) wastes are subject to federal treatment standards, only non-RCRA wastes were considered. Two waste treatability groups were identified, based upon the fact that all metals except hexavalent chromium can be directly precipitated and removed from aqueous media. Two major groups of demonstrated technologies for aqueous wastes with metals were identified. Chemical precipitation methods include lime or caustic precipitation, sulfide precipitation, and coprecipitation with ferrous sulfate, ferrous chloride or dithiocarbamate. Chemical and electrochemical reduction methods are used for the reduction of hexavalent chromium to the trivalent state. Demonstrated reducing agents are sodium metabisulfite, sulfur dioxide, ferrous sulfide, and other ferrous ions. The Department of Health Services of California has established feasible treatment levels for 13 regulated metals. An immediate effective date for the proposed treatment standards for metal-containing aqueous wastes is recommended, based on a finding that there is sufficient off-site commercial treatment capacity in California. (See also W91-05668) (MacKeen-PTT)
W91-05672

IMPLEMENTATION OF A HEAVY METALS REDUCTION PROGRAM IN THE CITY OF LOS ANGELES.
Los Angeles City Bureau of Sanitation, CA.
P. Costa, and B. W. Yohannes.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 204-205.

Descriptors: *Heavy metals, *Los Angeles, *Metal-finishing wastes, *Waste management, *Waste reduction, *Wastewater, *Water pollution control, Cadmium, California, Enforcement, Hazardous wastes, Industrial wastewater, Municipal wastewater, Standards, Water quality management.

A heavy metals reduction project was undertaken by the Los Angeles Bureau of Sanitation, Enforcement Division. The objectives of the project were: (1) identification of major contributing sources; (2) estimation of quantities; (3) program development; and (4) program implementation. After targeting cadmium as the metal of first concern, a phase I program was developed for an estimated cadmium reduction of 25-30%. The program consisted of an in depth monitoring and site assessment of firms known to be using cadmium. Process operations, pretreatment capabilities, wastewater discharge analysis and hazardous waste management techniques were reviewed at each site. Progressive enforcement actions were taken against facilities in violation of discharge standards, and limited on-site instruction on proper hazardous waste management techniques was given. A reduction in the amount of cadmium entering the energy-recovery system was observed as a result of the program implementation. (See also W91-05668) (MacKeen-PTT)
W91-05673

SOURCE REDUCTION OPPORTUNITIES IN THE PLATING INDUSTRY.
Minnesota Technical Assistance Program, Minneapolis.
For primary bibliographic entry see Field 5D.
W91-05674

SUBSTITUTING THERMAL SPRAYING FOR ELECTROPLATING.
Bender Machine, Inc., Vernon, CA.
D. Gansert, and G. Grenier.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 218-220.

Descriptors: *Environmental impact, *Environmental protection, *Industrial wastes, *Metal-finishing wastes, *Technology, *Waste reduction, *Water pollution control, Chromium, Electroplating, Hazardous wastes, Industrial wastewater, Nickel, Thermal spraying.

Thermal spray technology is increasingly being used as a replacement for environmentally-detrimental electroplating processes as a means of providing machinery parts with wear-resistant and corrosion-resistant coatings. Thermally-sprayed ceramic coatings have replaced chrome-plated water rolls in the printing industry. Chrome-plated rolls require acid etching, which is an environmental concern. Isopropyl alcohol is used to increase the wetting action on chrome rolls, but the volatility of this alcohol is also an environmental concern. Hasteloy C has replaced nickel and chrome plating on print cylinders and on composite rolls in the plastics industry. There has been a reduction in nickel platers because of increasing environmental pressure. (See also W91-05668) (MacKeen-PTT)
W91-05675

CLOSED LOOP PLATING SYSTEM FOR WASTE MINIMIZATION.
Foss Plating Company, Sante Fe Springs, CA.
L. Foss.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 221-223.

Descriptors: *Chromium, *Industrial wastes, *Industrial wastewater, *Metal-finishing wastes, *Waste reduction, *Wastewater management, *Water pollution control, Electroplating, Hazardous wastes, Industrial plants, Process control, Process modification, Water quality management.

In order to minimize wastes at a chrome plating plant, the hexavalent chromium used in the plating solutions was initially converted to trivalent chrome by addition of sodium bisulfite to a two-station counter current rinse. A closed loop system was then implemented in December 1986 and used until March 1989. Addition of the drag out tank contents to the chrome tank resulted in an increase in chrome content from 28 to 36 oz. The sulfate ratio was adjusted on a daily basis. After adjustment of the fluoride level, no problems were experienced in the plating process. Advantages of the system included: decrease in consumption of chrome, caustic, and sodium bisulfate, decreases in filter cake production, decrease in wastewater toxicity, and savings of $2000-3000 per month. (See also W91-05668) (MacKeen-PTT)
W91-05676

FERROUS FOUNDRY WASTE MINIMIZATION OPTIONS.
RMT, Inc., Madison, WI.
J. E. Vondracek.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 224-244. 10 fig, 10 ref.

Descriptors: *Hazardous wastes, *Industrial wastes, *Metal-finishing wastes, *Solid wastes, *Steel industry, *Waste management, *Waste reduction, *Water pollution control, Acetylene, Heavy metals, Hydrogen sulfide, Industrial plants, Process control, Process modification, Water quality management.

Recycling of scrap metals by the foundry industry can result in the generation of hazardous wastes. Two types of hazardous waste in the ferrous foundry industry are calcium carbide desulfurization slag and melt emission control residuals. Desulfurization slag reacts with water to form acetylene gas and may emit hydrogen sulfide gas under acidic conditions. Alteration of raw materials, improving process controls, and recycling to the original manufacturing processes are the best options for calcium carbide desulfurization slag management, assuming the product requirements cannot be modified enough to eliminate the generation this waste. Emission control residuals contain toxic metals, including copper, nickel, chromium, cadmium, molybdenum, tin, aluminum and lead. The best options for minimization of emission control wastes are alteration of raw materials and use of electric induction melting without air pollution control equipment. It is recommended that minimization options for this waste be assessed on a case-by-case basis. (See also W91-05668) (MacKeen-PTT)
W91-05677

CASE STUDY OF A MINIMUM DISCHARGE, HEAVY METAL WASTE REDUCTION SYSTEM AT AEROSCIENTIFIC CORPORATION, ANAHEIM, CALIFORNIA.
Toxic Recovery Systems International, Elk Grove, CA.
For primary bibliographic entry see Field 5D.
W91-05678

WASTE MINIMIZATION OF HAZARDOUS WASTE SOLUTIONS IN THE ELECTROPLATING AND PRECIOUS METALS INDUSTRY USING THE FINAL TREATMENT DISTILLATION UNIT.
Drew Resource Corp., Berkeley, CA.
For primary bibliographic entry see Field 5D.
W91-05681

RECOVERY OF METALS IN CIRCUIT BOARD AND METAL PLATING MANUFACTURING.
General Dynamics Corp., Pomona, CA. Pomona Div.
For primary bibliographic entry see Field 5D.
W91-05682

CHEMICAL FIXATION OF HEAVY METAL-CONTAMINATED SOILS.
Chemfix Technologies, Inc., Metairie, LA.
C. P. Lo, D. N. Silverman, and A. M. Porretta.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park Ridge, New Jersey. 1990. p 362-372. 1 fig, 6 tab, 9 ref.

Descriptors: *Chemical treatment, *Cleanup operations, *Heavy metals, *Metal-finishing wastes, *Soil contamination, *Soil treatment, *Waste stabilization, *Water pollution treatment, Performance evaluation, Silicates, Site remediation, Superfund, Waste treatment.

A recently developed chemical fixation method (Chemfix) for the treatment of heavy metal-contaminated soil is based on the use of soluble silicates and silicate setting agents. The combination and proportions of reagents are optimized for each particular waste requiring treatment. The two-part, inorganic chemical system reacts with polyvalent metal ions, other waste components and also with itself to produce a chemically and physically stable solid material. Treatment of spiked synthetic soil samples by the chemfix process reduced metal leachability by 96-100%. Kinetic analysis of the process indicated that the metal binding reactions took place almost instantaneously. The process was tested on soils from a Superfund site which was contaminated with heavy metals, particularly cobalt, cadmium and nickel, in concentrations ranging from 3000-5000 mg/kg. Leachate analysis of the treated soils indicated a long-term stability of the product. A full scale process with an estimated capacity of 250-350 cubic yards/day was designed. (See also W91-05668) (MacKeen-PTT)
W91-05691

BIOLOGICAL TREATMENT OF MERCURY WASTE.
Utah State Univ., Logan. Dept. of Nutrition and Food Science.
For primary bibliographic entry see Field 5D.
W91-05692

COPPER MINE DRAINAGE TREATMENT PLANT DRIVEN BY WATER WHEEL.
California Univ., Richmond. Richmond Field Station.
F. H. Pearson, and J. L. Potter.
IN: Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment, Noyes Publications, Park

Ridge, New Jersey. 1990. p 383-403. 9 fig, 3 tab, 19 ref.

Descriptors: *Copper, *Energy sources, *Heavy metals, *Metal-finishing wastes, *Mine drainage, *Mine wastes, *On-site wastewater treatment, *Wastewater treatment, *Water pollution treatment, Acid mine drainage, California, Industrial wastewater, Settling basins, Wastewater management, Water quality management.

An innovative wastewater treatment plant was designed, constructed and operated to remove toxic heavy metals from copper mine drainage at an isolated, subalpine site in Northern California. Though on pilot scale, up to 60% of wastewater from the mine was treated to remove an average of 72% of copper at high loadings, or 93% at lower loadings. Treatment involved neutralization first with crushed limestone, then with alkaline reagent solution to approximately pH 10, followed by settlement in a basin. Metals removal efficiency was limited by solids separation in the basin, which was consistent with fourth-order removal kinetics. Lacking electricity at the site, a water wheel was used to drive the three mechanized neutralization processes used. In one limestone process, a cylindrical drum packed with crushed stone rotates at several revolutions per minute to tumble and abrade the stone to fines which dissolve into the acidic water. The other limestone process is a drum rotating a few revolutions per day for attrition of coatings from crushed stone tumbling inside, which neutralizes water passing through the drum. Also connected to the water wheel is a metering pump to dispense a neutralizing solution. As the site is snowbound for about 6 months of the year, the treatment plant was designed to operate unattended for months at a time. Unattended operation over short periods was demonstrated, but after the final inspection before winter the wastewater supply from the mine to the treatment plant was interrupted by rupture of the feed pipe under snow loading, which also crushed two sheds at the site. However, a flume packed with crushed limestone to neutralize mine drainage operated continuously through the winter under snowpack. (See also W91-05668) (Author's abstract)
W91-05693

DENITRIFICATION OF LANDFILL LEACHATE BY THE MODIFIED ROTATING BIOLOGICAL CONTACTOR (RBC).
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 5D.
W91-05755

NUTRIENT REMOVAL BY HIGH RATE POND SYSTEM IN A MEDITERRANEAN CLIMATE (FRANCE).
Montpellier-2 Univ. (France).
For primary bibliographic entry see Field 5D.
W91-05762

EFFLUENT POLLUTION CONTROL OF OSAKA NORTH PORT DREDGED SOIL DISPOSAL SITE (NORTH SECTION-SITE II AND III).
Osaka City Inst. of Public Health and Environmental Sciences (Japan). Dept. of Environmental Technology.
For primary bibliographic entry see Field 5D.
W91-05771

COMPATIBILITY OF STREAM HABITAT RECLAMATION WITH POINT SOURCE AND NONPOINT SOURCE CONTROLS.
Colorado Univ. at Boulder.
J. T. Windell.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 9-13, January 1991. 1 fig.

Descriptors: *Ammonia removal, *Colorado, *Habitat restoration, *Riparian land, *Wastewater facilities, *Water pollution control, *Water quality control, *Water quality management, Denitrification, Land use, Nonpoint pollution sources, Stream improvement, Wastewater management, Wastewater treatment, Water pollution sources.

A series of studies done under contract with the city of Boulder (Colorado) Public Works was completed recently, in response to the need to adopt more stringent un-ionized ammonia and other water quality control standards, to upgrade an aging wastewater treatment plant, to determine the causes of deterioration (water quality and land-use problems) in Boulder Creek downstream from the plant, and to develop recommendations for remediation of the problems. Major recommendations proposed that aquatic and riparian habitat reclamation using selected best management practices (BMPs) would serve as a compliment to advanced wastewater treatment. The studies concluded that implementation of state-approved stream management practices downstream of the city's wastewater treatment plant (WWTP) could potentially eliminate the need for future denitrification towers, resulting in long-term cost savings for WWTP capital construction, operation, and maintenance. An aquatic and riparian habitat demonstration project was authorized to implement those BMPs that would reduce un-ionized ammonia excursions, control nonpoint source (NPS) pollution, restore habitat function, and encourage good land use practice. Phase I included construction of fencing to exclude cattle from riparian habitat; restoring stream stability by using log revetments; planting tree cuttings to regenerate riparian habitat; and creating boulder aeration structures to increase instream oxygen and carbon dioxide which lowers pH. Phase II includes an irrigation return-flow ditch that flows year-round. Phase III will use abandoned gravel pits for detention basins. Reported observations and documentation indicate that a final water quality management plan for the Boulder Creek Basin should include both point source and NPS pollution controls. (Fish-PTT)
W91-05802

CLARIFICATION AND FILTRATION TO MEET LOW TURBIDITY RECLAIMED WATER STANDARDS.
Kennedy/Jenks/Chilton, Inc., San Francisco, CA.
For primary bibliographic entry see Field 5D.
W91-05808

PENNSYLVANIA'S WATER QUALITY: HOW FAR WE HAVE COME, HOW FAR WE HAVE TO GO.
For primary bibliographic entry see Field 6B.
W91-05810

SIMPLE DERIVATION OF THE RETARDATION EQUATION AND APPLICATION TO PREFERENTIAL FLOW AND MACRODISPERSION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2F.
W91-05819

VALUING POTENTIAL GROUNDWATER PROTECTION BENEFITS.
Wyoming Univ., Laramie. Dept. of Economics.
For primary bibliographic entry see Field 6B.
W91-05831

QUESTION OF NITRATES.
Salford Univ. (England). Environmental Resources Unit.
For primary bibliographic entry see Field 5B.
W91-05904

DEVELOPMENT AND USE OF SITE-SPECIFIC CHEMICAL AND BIOLOGICAL CRITERIA FOR ASSESSING NEW BEDFORD HARBOR PILOT DREDGING PROJECT.
Environmental Research Lab., Narragansett, RI.
W. G. Nelson, and D. J. Hansen.
Environmental Management EMNGDC, Vol. 15, No. 1, p 105-112, January/February 1991. 2 fig, 2 tab, 17 ref.

Descriptors: *Biological properties, *Chemical properties, *Cleanup operations, *Decision making, *Dredging, *Evaluation, *Monitoring, *New Bedford Harbor, *Risk assessment, *Sediment contamination, *Site remediation, *Standards, *Superfund, *Water pollution control, Bioindicators, Heavy metals, Massachusetts, Polychlorinated biphenyls, Water sampling.

Numerical site-specific chemical and biological criteria were established to assess the impact of a pilot dredging project on water quality at the New Bedford Harbor, Massachusetts Superfund site. Because most existing chemical concentrations in the water column and indigenous biota exceeded federal and state water quality limits, the derivation of site-specific criteria was required. Prior to any operational phases of the project (i.e. dike construction, dredging), criteria values were developed from background concentrations of PCB's and metals in water and biota, as well as for the toxic effects of water quality on the biota. During each operational phase of the project, water samples were collected, analyzed within 16 hr, and the data supplied to a management committee in order to assess the environmental impact of the previous days' operation. The ambient unfiltered water concentration of PCB's and metals were the only chemical or biological criteria exceeded. Modification of the next days' operation resulted in a return of these concentrations to background levels. The combined use of site-specific criteria and real time decision making management process allowed for successful completion of this project with minimal effect on water quality. (Author's abstract)
W91-05907

WATER-QUALITY EFFECTIVENESS OF A DETENTION/WETLAND TREATMENT SYSTEM AND ITS EFFECT ON AN URBAN LAKE.
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 5D.
W91-05908

MYERS DUMP CASE HISTORY: INNOVATIVE UTILIZATION OF AIR STRIPPER-ACTIVATED CARBON TECHNOLOGIES.
Weston (Roy F.), Inc., Chicago, IL. Spill Prevention and Emergency Response Div.
J. S. Binkley, S. Matz, K. L. Myers, and K. Theisen.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 253-256, November 1989, 1 fig, 1 tab, 7 ref.

Descriptors: *Activated carbon, *Air stripping, *Cleanup operations, *Groundwater pollution, *Trichloroethylene, Adsorbents, Indiana, Myers Dump Site, Site remediation, Trihalomethanes, Volatile organic compounds.

The treatment of residential well water contaminated with volatile organic compounds (VOCs) has typically included the use of granulated activated carbon (GAC) filters. The significant carbon replacement costs associated with filtration has prompted research into more cost effective alternatives. An alternative for treatment of ground water contaminated with VOCs is air stripping. This process does not require extensive maintenance costs but it generally cannot achieve the required removal levels for small scale applications. The combination of these two technologies can result in achieving optimum removal levels while reducing carbon replacement costs. Past activities at the Myers Dump Site, Osceola, Indiana involved uncontrolled dumping of drums containing waste solvent into unlined pits and subsequent recycling of the drums the design of the treatment system implemented is a combination of a 1.78 m high countercurrent air flow stripping tower in tandem with two 45 kg GAC filters, with a calculated carbon usage rate of 3.54 kg of carbon per 3,785 L of water. Total system removal achieved a level of 99.9999% effectiveness. (Doyle-PTT)
W91-05913

USE OF CARBON ADSORPTION PROCESSES IN GROUNDWATER TREATMENT.
Calgon Corp., Pittsburgh, PA.
M. H. Stenzel, and W. J. Merz.
Environmental Progress ENVPDI, Vol. 8, No. 4, p 257-264, November 1989, 4 fig, 5 tab, 11 ref.

Descriptors: *Activated carbon, *Adsorption, *Cleanup operations, *Economic aspects, *Groundwater pollution, *Water pollution treatment, Cost analysis, Economic prediction, Organic pollutants, Performance evaluation, Site remediation, Trichloroethylene.

One of the leading treatment technologies for reduction of organic contaminants in groundwater has become the adsorption process utilizing granular activated carbon (GAC). A basic evaluation technique for activated carbon is the liquid phase adsorption isotherm with which a carbon usage rate can be established for economic analysis. Accelerated column tests (ACTs) have been used to model system performance by evaluating contact times and carbon usage rates. These tests show that systems with short contact times can obtain 45-50% of theoretical capacity of GAC before time of breakthrough. Annual operating costs for a single downflow fixed bed adsorber 10 ft in diameter, containing 20,000 lbs of GAC, and treating 350 gpm of 500 ppb trichloroethyene, typically achieve 99% removal efficiency in a range of 22-55 cents per 1000 gallons. Column studies are also useful in determining if a second stage treatment may improve carbon usage and optimize treatment costs. GAC adsorption systems are also useful removal of volatile organic compound contaminants from air in stripping processes. The decision of where to employ regenerable or non regenerable systems is based on the expected life of the remedial project. (Doyle-PTT)
W91-05914

BIOREMEDIATED SOIL VENTING OF LIGHT HYDROCARBONS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
D. W. Ostendorf, and D. H. Kampbell.
Hazardous Waste and Hazardous Materials HWHME2, Vol. 7, No. 4, p 319-334, Fall 1990, 5 fig, 4 tab, 34 ref, 2 append. National Center for Groundwater Research of Rice, Oklahoma, and Oklahoma State Universities Cooperative Agreement C$812808.

Descriptors: *Bioremediation, *Capillary zone, *Hydrocarbons, *Kinetics, *Soil aeration, *Soil contamination, Cleanup operations, Feasibility studies, Gasoline, Groundwater pollution, Michigan, Model studies.

The effectiveness and feasibility of bioremediated soil venting of light hydrocarbons in the unsaturated zone was tested by comparing field performance data in an unsaturated clay soil bioreactor for a propellant waste gas mixture of propane, n-butane, and isobutane against an analytical solution in which degradation mechanics were considered as a one dimensional balance of storage, linear sorption, vertical advection and Michaelis-Menton kinetics. The analytical theory was tested against field degradation data at Racine, Wisconsin, for a propellant waste gas mixture of propane, n-butane, and isobutane with reasonable accuracy, based on laboratory values for the kinetics. A series of venting simulations was run to assess the biodegradation of vapors above an aviation gasoline spill in sandy soil at Traverse City, Michigan, based on field and microcosm estimates of the kinetic parameters. Acclimated, nutrient rich soil effectively and feasibly reduced effluent vapor concentration from the strong influent concentration associated with dispersed residual gasoline in the contaminated capillary fringe. Aggregated residual contamination required a stronger airflow for a longer duration while natural kinetics were too slow for feasible and effective treatment by bioremediated soil venting at Traverse City. Laboratory studies of the air stripping characteristics of intact core samples from the Traverse City site are currently being conducted to provide corroborating evidence; the resulting data will be input to prototype tests by the US Coast Guard to establish field documentation of the feasibility and effectiveness of bioremediated soil venting at the site. (Doyle-PTT)
W91-05918

ION EXCHANGE TREATMENT OF SUBSURFACE DRAINAGE WATER.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
W. L. Magette, P. A. Pachero, and F. W. Wheaton.
Agricultural Water Management AWMADF, Vol. 18, No. 2, p 121-132, July 1990. 3 fig, 6 tab, 17 ref.

Descriptors: *Ion exchange, *Nitrates, *Return flow, *Subsurface drainage, *Water pollution treatment, Agricultural runoff, Fertilizers, Laboratory methods, Sulfates.

A laboratory study was conducted to investigate the single-bed anion exchange process for removal of nitrogen nitrate from agricultural subsurface drain outflow. Tests were performed in duplicate at flow rates of 103 ml/min and 512 ml/min, respectively, using both synthetic and natural drainage water. Nitrate breakthrough occurred at nearly the same column volumes for both flow rates. Sulfate competed strongly for exchange sites decreasing the efficiency of the resin to absorb nitrate. The anion exchange process has the potential for removing NO(3)N from drainage outflow, however several technical and economic problems must be solved before it can be applied in the field . (Author's abstract)
W91-05924

LABORATORY RECLAMATION STUDY FOR SODIC SOILS USED FOR RICE PRODUCTION.
Chonbuk National Univ. (Republic of Korea).
J. W. Koo, R. J. Edling, and V. Taylor.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 243-252, September 1990. 1 tab, 5 fig, 9 ref.

Descriptors: *Impervious soils, *Rice, *Sodic soils, *Soil chemistry, *Soil reclamation, *Soil texture, Gypsum, Laboratory methods, Leaching, Saline soils, Soil management, Soil treatment.

Soils used for rice production are characteristically nearly impervious to water movement. Therefore, sodic rice soils are difficult to reclaim by techniques that depend upon leaching. A study was conducted to compare rinsing and leaching techniques for two coarse textured and one fine textured soil. Three levels of gypsum treatment (0.4.5 and 9.0 t/ha) were used. The rinsing involved mixing the gypsum treatment with the soil, mixing the soil-gypsum mixture with water, letting the soil settle and decanting the supernatent water. Four sequential extractions of either the supernatant liquid or leachate were conducted. Rinsing and leaching methods were effective in reducing SAR, ESP and EC in the two coarse textured soils. Leaching was not possible for the fine textured soil; however, rinsing significantly reduced the sodic content of the soil. Treatments of 4.5 and 9.0 t/ha gypsum were more efficient than treatments without gypsum. Leaching following .5 t/ha of gypsum treatment is effective in reclaiming sodic soils, provided drainage through the soil is adequate. The rinsing method with 4.5 t/ha of gypsum treatment has potential as a reclamation method, when drainage through the soil is poor. (Author's abstract)
W91-05933

ALASKA'S RESPONSE TO THE EXXON VALDEZ OIL SPILL.
Alaska State Dept. of Environmental Conservation, Juneau.
D. D. Kelso, and M. Kendziorek.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 16-23, January 1991. 3 fig, 17 ref.

Descriptors: *Alaska, *Cleanup operations, *Exxon Valdez, *Oil spills, *Prince William Sound, *Water pollution effects, Accidents, Fishkill, Management, Marine mammals, Oil dispersants, Oil pollution, Oil recovery, Technology, Water birds.

When the tanker Exxon Valdez spilled nearly 11 million gallons of crude oil in Prince William Sound, Alaska, an estimated 100,000-300,000 sea birds, thousands of marine mammals, and hundreds of bald eagles were killed. The spill also disrupted the herring and salmon harvests of commercial and subsistence fisheries that had consistently supported communities in the spill area. The response to the spill was conducted in three phases: (1) immediate containment and recovery of oil from the water; (2) emergency removal of oil from the shoreline; and (3) long-term shoreline treatment to remove oil. In addition to the direct spill response, state and federal agencies also initiated natural resource damage assessment and restoration efforts. In fact, the technology available to carry out these strategies was inadequate. In the Exxon Valdez spill, the combination of technology limitations and management problems resulted in massive damage and limited cleanup. The primary lesson of the Exxon Valdez spill is that oil spill prevention and response technologies need substantial, sustained research and development. There must be adequate amounts of equipment in place in time to properly respond to an oil spill. Management systems need to be improved so they effectively use these technologies. (See also W91-05947) (White-Reimer-PTT)
W91-05946

EXXON VALDEZ OIL SPILL: INITIAL ENVIRONMENTAL IMPACT ASSESSMENT.
Exxon Co. USA, Anchorage, AK.
For primary bibliographic entry see Field 5C.
W91-05947

BIODEGRADATION OF AROMATIC HYDROCARBONS BY AQUIFER MICROORGANISMS UNDER DENITRIFYING CONDITIONS.
Robert S. Kerr Environmental Research Lab., Ada, OK.
S. R. Hutchins, G. W. Sewell, D. A. Kovacs, and G. A. Smith.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 68-76, January 1991. 6 fig, 2 tab, 34 ref.

Descriptors: *Aquifers, *Biodegradation, *Bioremediation, *Cleanup operations, *Denitrification, *Hydrocarbons, *Laboratory methods, *Microbial degradation, *Water pollution treatment, Benzenes, Fuel, Nitrates, Nutrients, Toluene, Xylenes.

A series of laboratory tests was conducted to evaluate whether denitrification would be a suitable alternative for biorestoration of an aquifer contaminated with JP-4 jet fuel. Microcosms were prepared from both uncontaminated and contaminated aquifer material from the site, in an anaerobic glovebox, amended with nitrate, nutrients, and aromatic hydrocarbons, and incubated under a nitrogen atmosphere at 12 C. With uncontaminated core material, there was no observable lag period prior to removal of toluene whereas 30 days was required before biodegradation commenced for xylenes, ethylbenzene, and 1,2,4-trimethylbenzene. An identical test with contaminated aquifer material exhibited not only much longer lag periods but decreased rates of biodegradation; benzene, ethylbenzene, and 0-xylene were not significantly degraded within the 6-month time period even though active denitrification occurred at this time. First-order biodegradation rate constants ranged from 0.016 to 0.38/d for uncontaminated core material and from 0.022 to 0.067/d for contaminated core material. Tests with individual compounds in uncontaminated core indicated that benzene and m-xylene inhibited the basal rate of denitrification. These data demonstrate that several aromatic compounds can be degraded under denitrifying conditions, but rates of biodegradation may be lower in material contaminated with JP-4 jet fuel. (Author's abstract)
W91-05949

STUDY OF ADSORPTION–DESORPTION OF CONTAMINANTS ON SINGLE SOIL PARTICLES USING THE ELECTRODYNAMIC THERMOGRAVIMETRIC ANALYZER.
Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
L. Tognotti, M. Flytzani-Stephanopoulos, A. F. Sarofim, H. Kopsinis, and M. Stoukides.

Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 104-109, January 1991. 9 fig, 3 tab, 30 ref. Center for Environmental Management of Tufts University Grant CR-813481-02-0.

Descriptors: *Cleanup operations, *Hazardous waste disposal, *Soil contamination, *Soil properties, *Soil types, *Water pollution prevention, Carbon tetrachloride, Electrodynamic thermogravimetry, Toluene.

The increasing public and scientific concern with the problem of hazardous waste disposal has initiated and promoted the study of fundamentals associated with such waste treatment processes. Recent studies have pointed out the importance of adsorption and desorption of contaminants in the soil particles during incineration. The development of several thermal and nonthermal soil decontamination techniques will involve the use of contaminant desorption. The electrodynamic thermogravimetric analyzer (EDTGA) was used to study the adsorption and desorption of organic compounds on single particles of several porous soils. The isothermal adsorption and desorption of organic vapors on a single soil particle were examined. Toluene and carbon tetrachloride were tested at room temperature during their adsorption on Spherocarb, montmorillonite, and Carbopack particles. The maximum amount of either organic compound adsorbed was comparable to that required for one monolayer coverage of the particle surface area. Significant differences among various pairs of solid-organic vapor examined were identified and correlated to differences in solid pore structure and chemical affinity between the organic compound and the solid. Montmorillonite adsorbs the largest amount of C7H8 and CCl4, and it has the largest intrusion volume. Spherocarb came next, although it has the highest surface area. This can be explained by taking into account that Spherocarb consists mainly of micropores. Formation of liquid in pores of that size is highly likely and this could inhibit penetration of the organic compound inside the particle. EDTGA is a useful tool for studying the fundamentals of contamination and decontamination of porous soils. It can also be used for continuously measuring the temperature and weight of a heated particle during small intervals of time. (White-Reimer-PTT)
W91-05953

SOLUBILIZATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN MICELLAR NONIONIC SURFACTANT SOLUTIONS.

Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.
D. A. Edwards, R. G. Luthy, and Z. Liu.

Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 127-133, January 1991. 8 fig, 4 tab, 34 ref. EPA Grant 12-815325-01-0.

Descriptors: *Cleanup operations, *Earth-water interfaces, *Hydrocarbons, *Organic compounds, *Path of pollutants, *Site remediation, *Soil contamination, *Surfactants, Naphthalenes, Phenanthrene, Pyrene, Sediment contamination, Solubility.

Hydrophobic organic compounds, such as polycyclic aromatic hydrocarbons (PAHs), are of special interest in soil contamination because they are strongly sorbed to soil or sediments. As a result, remediation of hydrophobic organic contamination in soil-water systems is often dependent on desorption of the contaminant from the soil surface and subsequent incorporation of the pollutant into the bulk aqueous phase. Experimental data are presented on the enhanced apparent solubilities of naphthalene, phenanthrene, and pyrene resulting from solubilization in aqueous solutions of four commercial, nonionic surfactants: an alkyl polyoxyethylene (POE) type, two octylphenol POE types, and a nonylphenol POE type. Apparent solubilities of the PAH compounds in surfactant solutions were determined by radiolabeled techniques. Solubilization of each PAH compound commenced at the surfactant critical micelle concentration and was proportional to the concentration of surfactant in micelle form. The partitioning of organic compounds between surfactant micelles and aqueous solution is characterized by a mole fraction micelle-phase/aqueous-phase partition coefficient, Km. Values of log Km for PAH compounds in surfactant solutions of this study range from 4.57 to 6.53. Values of log Km for a particular surfactant-PAH system appear to be correlated with PAH octanol-water partition coefficients. A knowledge of partitioning in aqueous surfactant systems is a prerequisite to understanding mechanisms affecting the behavior of hydrophobic organic compounds in soil-water systems in which surfactants play a role in contaminant remediation of facilitated transport. (Author's abstract)
W91-05954

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

APPLICATION OF QUANTITATIVE RISK ASSESSMENT EVALUATION OF UNDERGROUND STORAGE TANKS TO INSURANCE, BANKING, AND REAL ESTATE TRANSACTIONS.

Versar, Inc., Springfield, VA. Underground Storage Tank Branch.
J. Casana, and G. Dixon.

IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 321-327, 2 fig, 3 tab.

Descriptors: Waste management, *Risk assessment, *Underground storage tanks, *Financial aspects, *Waste disposal, Insurance, Real estate, Costs, Soil properties, Hydraulic conductivity, Leakage, Path of pollutants.

A simple and effective risk assessment procedure has been developed as part of an overall risk management program for underground storage tanks. Risk rating procedures and their use in an insurance and property transfer application are described. Two sets of criteria are used to quantify risks and prioritize tanks. The first set consists of release potential characteristics (e.g., frequency of release), such as tank age, corrosion protection controls, leak detection controls, tank design and soil corrosivity. The second set of criteria consists of site vulnerability factors, such as depth to water table, soil hydraulic conductivity, surrounding population, aquifer use, and proximity to surface waters. Over time, the risk rating system would greatly reduce the tank owner's expenditures by allowing him to focus his resources where they are most needed. Similarly, the insurance company would be able to provide competitive rates by being able to efficiently identify and address the highest risk tanks first. Ultimately, the significant savings in tank upgrading/insurance costs and in reduced claims will be passed to the general public through lower retail prices. (See also W91-05236) (Lantz-PTT)
W91-05261

INTERNATIONAL PROGRAMME FOR ENVIRONMENTALLY SOUND HYDROLOGIC AND WATER MANAGEMENT STRATEGIES IN THE HUMID TROPICS.

United Nations Educational, Scientific and Cultural Organization, Paris (France). International Hydrological Programme.
J. S. Gladwell, and M. Bonell.

IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 1-10, 1 tab, 2 ref.

Descriptors: *Developing countries, *Humid climates, *International agreements, *Tropical hydrology, *Tropical regions, *Water resources management, Human population, Management planning, Research priorities, Sedimentation, Water quality, Water quality management.

The problems of the humid tropics and other warm humid regions have been identified through a series of mechanisms, most recently by the International Colloquium on the Development of Hydrologic and Water Management Strategies in the Humid Tropics. The problems are numerous and their solutions are expensive. With the exception of relatively small areas, this region consists almost entirely of developing countries. Additionally, it has been estimated that by the end of this century nearly half of the worlds' population will be living in the region. The results of neglecting these problems will be felt worldwide. It was the consensus of this colloquium that if the disadvantages are to be overcome, the following steps should be taken: (1) research efforts into all aspects of the hydrologic cycle within the humid tropics should be strengthened and encouraged; (2) research efforts in the identification and measurement of sediment/water quality sources and storage, and processes of transfer at a catchment scale with particular reference to rural areas; (3) quantify the physical and economic effectiveness of land rehabilitation methods and programs on the hydrology, sediment and water quality within the framework of water management at the catchment scale; (4) particular urgency should be given to the research needs of urbanized areas with respect to the hydrology and water quality; (5) long-term monitoring of rainfall, climate and streamflow within the basin systems of the region should be continued and extended, taking care to match these programs to the capacities of the countries involved; (6) integrated watershed/river basin planning at both an international and regional level must be developed and policy decisions coordinated; (7) education opportunities must be expanded and curricula designed to respond to the needs of managers who can interpret conditions and implement policies across a range of disciplines; and (8) institutional arrangements for regional and world-wide coordinated cooperative research, education and training, and other aspects of the humid tropics and other warm humid regions should be developed. (See also W91-05611) (Lantz-PTT)
W91-05612

RESERVOIR PLANNING FOR IRRIGATION DISTRICT.

Iran Univ. of Science and Technology, Tehran. Dept. of Civil Engineering.
A. Afshar, M. A. Marino, and A. Abrishamchi.

Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 74-85, 1991. 3 fig, 5 tab, 21 ref. Agricultural Research Service Cooperative Agreements 4116-H and 4350-H.

Descriptors: *Irrigation design, *Reservoir design, *Water resources management, Cost analysis, Decision making, Irrigable land, Land development, Model studies, Reservoir capacity, Reservoir operation, Water demand, Water-carrying capacity, Watershed management.

Due to increasing water demands and water scarcity, greater attention is being given to water resource development and management in irrigated agriculture. Any modeling study dealing with surface reservoir system design for irrigation must realize the interdependency of three decision variables: reservoir capacity, distribution system capacity, and hectares of land to be developed for irrigation as well as its allocation to given crops. A mixed integer linear optimization model for river basin development for irrigation has been proposed. The model is a chance-constrained optimization model that considers the interactions between design and operation parameters. The model is capable of integrating all decision variables in the design phase, thus accounting directly for any interdependency between the design variables. The model uses a mixed integer technique to linearize the nonlinear cost functions and is applicable to concave and convex cost functions. Solution of the model provides the optimum extent of the land development for irrigation, cropping pattern, reservoir and canal capacities, as well as the necessary linear decision rule operational parameters. Also, solution of the model reveals the importance of direct inclusion of the reservoir cost in the model

in comparison to only minimizing the reservoir capacity under an assumed demand distribution. (Author's abstract)
W91-05791

MODEL FOR INVESTMENT APPRAISAL OF GRASSLAND DRAINAGE SCHEMES ON FARMS IN THE U.K.
AFRC Inst. of Grassland and Animal Production, Hurley (England).
For primary bibliographic entry see Field 4A.
W91-05923

6B. Evaluation Process

APPLICATION OF QUANTITATIVE RISK ASSESSMENT EVALUATION OF UNDERGROUND STORAGE TANKS TO INSURANCE, BANKING, AND REAL ESTATE TRANSACTIONS.
Versar, Inc., Springfield, VA. Underground Storage Tank Branch.
For primary bibliographic entry see Field 6A.
W91-05261

ECONOMIC DECISION-MAKING FRAMEWORK FOR ANALYZING ATMOSPHERIC DEPOSITION IMPACTS IN EASTERN U.S. FORESTS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Forestry.
W. A. Leuschner, J. M. Ferguson, and J. E. de Steiguer.
Journal of Environmental Management JEVMAW, Vol. 31, No. 4, p 367-389, Dec 1990. 5 tab, 71 ref. USDA/Forest Service Cooperative Research Agreement No. 29-194.

Descriptors: *Acid rain, *Acid rain effects, *Air pollution effects, *Decision making, *Economic impact, *Environmental impact, *Forest management, Cost-benefit analysis, Evaluation, Logging, Recreation demand, Scenery, Water use, Wildlife.

The potential effects of pollutants, to the extent they injure trees, are mortality, growth loss, predisposition to secondary pathogens and stresses, visible damage, and loss of reproductive vigor. Impacts on forest outputs include changing the quality, quantity, and timing of timber yields from existing and subsequent stands. Recreation and scenic beauty impacts are most likely to be reflected by users who discontinue the activity, users who substitute another site or activity, or users who continue the activity as before but have decreased enjoyment. Techniques of estimating recreational value (and the impact of atmospheric deposition thereon) include the 'travel cost method', which is particularly useful for estimating loss of recreational value for site-discontinued users, and 'contingent valuation', whose appeal lies in its ability to estimate a price for aesthetic values. Water impacts seem least likely to occur but would be measured by changes in yield, quality, and timing if they did. Among the more-easily-evaluated water-use impacts are the availability of water for hydroelectric power generation, dilution of waste product effluents, and for irrigation, industrial, and municipal use. Wildlife impacts will be reflected in changes in species and population numbers. (Doyle-PTT)
W91-05387

PUBLIC ATTITUDE TOWARDS WATER AND WATER REUSE.
Qatar Univ., Doha. Faculty of Engineering.
S. Ahmad.
Water Science and Technology WSTED4, Vol. 23, No. 10/2, p 2165-2170, 1991. 3 fig, 3 tab, 12 ref.

Descriptors: *Attitudes, *Qatar, *Social aspects, *Surveys, *Water reuse, *Water supply, Color, Irrigation water, Public participation, Reclaimed water, Wastewater utilization, Water conservation, Water consumption, Water quality.

A survey was taken in Doha, the capital city of Qatar, to assess the perception and attitudes of the consumers towards water supply and water reuse. A questionnaire was distributed to about 100 people which included questions about method of supply, quantity and quality of water, use of bottled water and filters in homes, awareness and concern about the high cost of water production, willingness to pay the cost of water, response towards water conservation and water reuse, awareness towards water reuse in Qatar and elsewhere, its significance to the society and any prejudices towards water reuse. In spite of the fact that the region is arid, and mostly desalinated water is used, the water supply is very generous. This is evident by the fact that the water consumption varies between 640 to 750 L/person/day. However, the water is subsidized by the government and is supplied at a minimal cost. Survey results indicated that the water is corrosive and often acquires a red color. Because of this, home filters are used in the kitchen and washer to get rid of the color and taste in water. People are aware of the high cost of water production and supply in such an arid region, but they did not respond positively towards sharing the cost of improvement in the water supply in spite of the fact that they currently play very little for receiving more than an adequate water supply. The community in general was not well informed about the water conservation measures and the water reuse. People seemed to be prejudiced against water reuse. A large percentage of respondents did not favor water reuse in lawns and gardens, car washing, toilet flushing, industries and farming. There is a need for better communication between the water departments and the community for implementing water conservation. For the present, water reuse should be limited to landscaping along the roads and irrigation of farms for growing animal fodder. (Mertz-PTT)
W91-05546

USER-SPECIFIC WATER DEMAND ELASTICITIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 6D.
W91-05790

ALTERNATIVE WATER-DISTRICT ORGANIZATION: SCREENING-LEVEL ANALYSIS.
California State Dept. of Water Resources, Sacramento.
C. Enright, and J. R. Lund.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 86-107, 1991. 11 fig, 4 tab, 24 ref.

Descriptors: *Management planning, *Water demand, *Water districts, *Water resources management, *Water supply, Alternative planning, California, Cost-benefit analysis, Economic evaluation, Mathematical equations, Municipal water, Prices.

The new era of scarce water supplies will require organizational reform to respond flexibly to future supply limits. Several water-district organization alternatives were investigated using data and demand functions from a municipal water district in northern California. A mathematical program found optimal seasonal allocations and water prices for the district's sales to several water users. The net economic benefits produced by the current water-district organization were compared with the net benefits produced by alternative 'mutual stock' organizations. Dual variables and sensitivity analysis indicated aspects of optimal district organization and the economic potential of water trade under different hydrologic regimes. For conditions where water availability varies greatly between years, results indicated that optimized fixed shares of the mutual stock might improve the net economic product of the district, but not necessarily by large amounts. (Author's abstract)
W91-05792

CLIMATIC SENSITIVITY OF CALIFORNIA WATER RESOURCES.
Washington Univ., Seattle. Dept. of Civil Engineering.
D. P. Lettenmaier, and D. P. Sheer.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 108-125, 1991. 8 fig, 5 tab, 19 ref. U.S. Environmental Protection Agency Cooperative Agreement CR814637.

Descriptors: *California, *Climatic changes, *Global warming, *Greenhouse effect, *Rainfall-runoff relationships, *Water resources management, *Watershed management, Alternative planning, Model studies, Reservoir operation, Runoff volume, Seasonal variation.

The State of California and the federal government have enormous investments in facilities designed to deal with the vagaries of climate in California. The possible effects of climate change on the combined Central Valley Project-California State Water Project (CVP/SWP) were evaluated using a three-stage approach. In the first stage, runoff from four headwater 'study catchments' was simulated using rainfall/snowmelt-runoff models, with climatic input taken from CO2 doubling scenarios from three general circulation models (GCMs). In the second stage, long-term inflows to the CVP/SWP reservoir system were simulated, conditioned on the study catchment flows, using a stochastic disaggregation model. In the third stage, a system simulation model was used to evaluate the performance of the reservoir system. It was found that for all of the alternative climate scenarios, runoff would be shifted from the spring to the winter. Significantly lower water deliveries from the SWP would occur under the CO2 doubling scenarios. The reduced deliveries would occur because some of the increased winter runoff would be spilled from the reservoirs instead of being stored in the snowpack, even though the mean annual runoff increased slightly under some climatic scenarios. Annual San Francisco Bay delta flows would increase under all three climate scenarios; however, flows to the bay would be substantially increased in winter and somewhat decreased in spring and summer. (Author's abstract)
W91-05793

PENNSYLVANIA'S WATER QUALITY: HOW FAR WE HAVE COME, HOW FAR WE HAVE TO GO.
P. H. Woodruff.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 1, p 12-16, January/February 1990. 9 fig.

Descriptors: *Nonpoint pollution sources, *Pennsylvania, *Water quality control, *Water quality management, *Water resources management, Acid mine drainage, Biological oxygen demand, Clean Water Act, Hazardous wastes, Regulations, Runoff, Storage tanks, Water pollution sources.

Water quality in Pennsylvania and throughout the U.S. has been maintained or improved in the last 15 years, despite an increase in the number of pollution sources and the increasingly complex nature of the problem. The Construction Grants Program and the National Pollution Discharge Elimination System (NPDES) permits program, two of the largest point source pollution control programs initiated under the Clean Water Act of 1972, are designed to depend heavily on individual states for guidance and implementation. Biological oxygen demand (BOD) levels discharged to Pennsylvania waterways were dramatically reduced (5.3 to 3.1 million population equivalents), possibly the most significant success in water quality efforts in the past 20 years. Since the 1970s, there has been an increasing realization that nonpoint source pollution (urban runoff, pesticide runoff from farmland, acid drainage from abandoned mines, and acid rain) and hazardous waste problems (industrial discharges to waterways, air emissions, hazardous waste sites) require adoption of diverse and far-reaching strategies. In Pennsylvania, nonpoint source pollution is the most significant threat to water quality; acid mine drainage is responsible for more than half of the overall damage from toxic substances, and it will cost an estimated $13-$15 billion to reclaim all abandoned mines. The number one threat to groundwater is leaking underground storage tanks (35,000 out of 100,000).

The techniques which are helping toward a global environmental solution--environmental education, awareness, and regulation where appropriate--will also help toward better water quality. (Fish-PTT)
W91-05810

MAJOR UNIT PROCESS EVALUATION USING THE COMPOSITE CORRECTION PROGRAM APPROACH.
GPU Nuclear Corp., Middletown, PA.
For primary bibliographic entry see Field 5D.
W91-05811

VALUING POTENTIAL GROUNDWATER PROTECTION BENEFITS.
Wyoming Univ., Laramie. Dept. of Economics.
T. D. Crocker, B. A. Forster, and J. F. Shogren.
Water Resources Research WRERAQ, Vol. 27, No. 1, p 1-6, January 1991. 28 ref.

Descriptors: *Cost-benefit analysis, *Economic aspects, *Groundwater protection, *Water pollution prevention, *Wellhead protection, Behavior, Groundwater pollution, Regulations, Risk assessment, Value.

Individuals often employ self-protective activities to reduce the probability or severity of asset loss, such as contamination of their groundwater supply. That is, the individual's risks from groundwater contamination can be endogenous. The implications of endogenous risks for the economic value of preventing groundwater contamination were examined. The analytical implications were considered of five key building blocks frequently used to structure the groundwater valuation literature: the probability and location of contamination; the exposed population; risk perceptions; and intertemporal issues. In general, this analysis demonstrated that disregard of endogenous risk can cause the straightforward, piecemeal application of conventional cost-benefit analysis to underestimate the value of groundwater protection, potentially leading to a cumulative loss of groundwater resources. It is argued that the current focus of groundwater protection cost-benefit analysis is misdirected because it fails to disentangle private and collective contributions to risk reduction. Regulations banning a given environmental state that do not consider the individuals' views of their own self-interest and their willingness to employ discretion (endogenous risk) have economic consequences that are unpredictable. (Rochester-PTT)
W91-05831

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ABCS OF SRFS.
For primary bibliographic entry see Field 5D.
W91-05071

TOWARD ECONOMICALLY EFFICIENT MANAGEMENT OF UNDERGROUND STORAGE TANKS: A RISK-BASED APPROACH.
Little (Arthur D.), Inc., Cambridge, MA.
For primary bibliographic entry see Field 5G.
W91-05264

EFFECTS OF PRICING POLICIES ON WATER CONSERVATION AND DRAINAGE.
California Univ., Santa Barbara. Dept. of Economics.
M. Caswell, E. Lichtenberg, and D. Zilberman.
American Journal of Agricultural Economics AJAEBA, Vol. 72, No. 4, p 883-890, November 1990. 2 fig, 1 tab, 8 ref.

Descriptors: *Conservation, *Drainage, *Model studies, *Water policy, *Water rates, Agriculture, California, Drainage practices, Economic aspects, Irrigation, Resources management.

A model for analyzing the adoption of input-conserving technologies is presented. The model abstracts several important facets of adoption decisions. Important extensions include incorporating within-firm heterogeneity such as variations in land quality within a field, aggregation to the industry level and, most important, dynamic considerations such as the impacts of changes in resource scarcity and environmental damage over time on the adoption process. The conceptual model is based on the profit-maximizing behavior of farmers with varying land quality. While the model is presented in terms of irrigation and drainage management, the concepts are applicable to a broad variety of inputs used in agricultural or industrial production. An environmental regulation such as a drainage effluent charge is shown to influence adoption. Early adopters are likely to be producers with less efficient fixed assets (land of low quality or antiquated capital), higher input costs (higher water prices or greater depth to groundwater), and in more environmentally sensitive regions. A numerical simulation model based on irrigation and drainage in cotton production in the western San Joaquin Valley, California, illustrates the relative importance of conservation and pollution policies for solving a major agricultural problem. The simulations show that drainage regulations can be expected to play a major role in the adoption of more efficient irrigation technologies in California. Thus, conservation may be a key to solving resource scarcity problems and reducing external environmental costs. (Agostine-PTT)
W91-05484

STORMWATER MANAGEMENT UTILITY BILLING RATE STRUCTURE.
CH2M Hill, Inc., Gainesville, FL.
J. E. Scholl.
Water Environment & Technology WAETEJ, Vol. 3, No. 1, p 47-49, January 1991. 1 tab.

Descriptors: *Metropolitan water management, *Public utility districts, *Storm water management, *Water rates, Ordinances, Policy making, Taxes, User charges, Wastewater management.

The development of a rate structure is critical to the successful implementation and operation of a storm water management utility. Once an appropriate rate structure is established, procedures for billing and database management requirements can be established. Charges for storm water runoff must be fair, reasonable, and easy to understand; and policy decisions related to charges must be legal and locally acceptable. The basic algorithm for calculating charges must be readily available, reasonably accurate, and technically defensible. Revenue requirements must be documented and represent the actual service costs, and rates must be set to generate adequate revenues to provide visible service benefits to customers. The most fundamental policy issue is who must pay for services. The basis for calculating individual charges can be developed, typically from the amount of storm water generated from property. Funding and expenditures on existing and desired services must be compared to establish the revenue requirements, and policy decisions can then provide direction on changes to be made. With the policy decided, quantifying the total number of billing units available to the jurisdiction of the affected local government is possible, often based preliminarily on property tax roll data and then specified according to the adopted rate structure criteria using a computerized spreadsheet approach. Public awareness is critical to successful implementation, although the local legislative body can establish the utility by adoption of an ordinance. Consideration for preparing the billing data include the number of parcels to be measured, the time available to do the work, and the tolerance for accepting errors. (Fish-PTT)
W91-05805

ECONOMICS OF EROSION AND SEDIMENT CONTROL IN SOUTHWESTERN ONTARIO.
Guelph Univ. (Ontario). Dept. of Agricultural Economics and Business.
For primary bibliographic entry see Field 4D.
W91-05849

ECONOMICS OF SOIL EROSION AND CONSERVATION ON SIX SOIL GROUPINGS IN MANITOBA.
Agriculture Canada, Brandon (Manitoba). Research Station.
For primary bibliographic entry see Field 2J.
W91-05938

6D. Water Demand

HYDROSTATION RESERVOIRS AND RECREATION.
For primary bibliographic entry see Field 8A.
W91-05086

WATER SUPPLY CHALLENGE IN THE GULF REGION.
Water Membrane Mfg. Co., Jeddah (Saudi Arabia).
For primary bibliographic entry see Field 3D.
W91-05192

FRAMEWORK FOR INCORPORATING STREAM USE IN THE DETERMINATION OF PRIORITY WATERSHEDS.
Wisconsin Univ.-Green Bay. Coll. of Environmental Sciences.
R. B. Wenger, Y. Rong, and H. J. Harris.
Journal of Environmental Management JEVMAW, Vol. 31, No. 4, p 335-350, Dec 1990. 9 fig, 7 tab, 11 ref.

Descriptors: *Environmental policy, *Model studies, *Stream classification, *Stream use, *Water use, *Watershed management, Agricultural runoff, Aquatic habitats, Kewaunee River Basin, Lotic environment, Nonpoint pollution sources, Stream fisheries, Wisconsin.

A methodological framework is presented which allows planners to take stream use into account in the determination of priority watersheds. The framework provides a formal structure for organizing non-point source data such as the number and size of barnyard and animal operations per unit area, and the number of feet of streambed in need of protection. These are compared with physical variables which include turbidity, dissolved oxygen, and substrate type together with existing models on habitat suitability for three species of fish, in a manner suitable as inputs to two fuzzy set models. The fuzzy set models incorporate the imprecision and fuzziness characteristic of non-point source water pollution problems. Such relationships lack precision but have the virtue of preserving relative relationships and describing general trends. In an illustrative application to the Kewaunee River Basin in Wisconsin, the methodology is used to identify priority watersheds when streams are categorized on the basis of potential fisheries. (Doyle-PTT)
W91-05386

PREFERRED ALTERNATIVE USES OF WATER RESOURCES: VIEWS OF ENVIRONMENTAL ACTIVISTS IN THE U.S. VIRGIN ISLANDS.
Nevada Univ., Las Vegas. Dept. of Political Science.
D. L. Soden.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 11-17, 3 tab, 19 ref.

Descriptors: *Political aspects, *Public opinion, *Tropical hydrology, *Virgin Islands (US), *Water allocation, *Water conservation, *Water resources management, *Water use, Competing use, Decision making, Economic aspects, Local governments, Policy making, Water resources development.

Perceptions of environmental activists and non-activists about alternative uses of water resources are linked systematically to a preservationist vs. developmentalist belief orientation. Based on aggregate analyses of survey data, individual case

studies can be compared to determine the extent to which localized developments yield results independent from those derived from survey data. Local political settings, especially in areas in great need of economic influx can render results quite different from those obtained initially. For example, the need for economic development may direct choices about water resources uses which are more consumptive in fashion, but preservationist forces may be expected to react among environmental activists regardless of the situation. Important to note is the large middle-of-the-road group of 'conservationists' which may act as a significant swing group favoring action in one instance along a developmental line, while in another supporting preservationist actions. Recognition of the existence of the preservationist-developmentalist distinction, and the existence of a large 'swing' group who may be a galvanized into action for either development or preservation, can be a very advantageous guide for those involved in policy and decision making attendant to water resources in tropical regions and aid them in better understanding of the issues at hand. (See also W91-05611) (Lantz-PTT)
W91-05613

USER-SPECIFIC WATER DEMAND ELASTICITIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
M. L. Schneider, and E. E. Whitlatch.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 117, No. 1, p 52-73, 1991. 8 tab, 36 ref.

Descriptors: *Elasticity of demand, *Model studies, *Ohio, *Water demand, *Water users, Least squares method, Model testing, Prices, Regression analysis, Water use.

A large number of studies have investigated water demand relationships for total municipal and residential water use; however, relatively few studies have dealt with water demand disaggregated by user class. Water demand elasticity was estimated for six user categories: residential, commercial, industrial, government, school, and total metered. Eight generalized least-squares, linear regression models were derived for each user category. Explanatory variables tested were price, per capita income, resident population per user account, housing composition, and summer precipitation. Pooled cross-sectional and time series annual data from the city of Columbus, Ohio, and incorporated suburbs were used. The recommended regression was a partial adjustment, generalized least-squares model with cross-sectional dummy variables. Price is a significant factor for all user categories except industry. The greatest price effect was for school accounts, followed by commercial, government, total metered, and residential. Governmental and school demands were most responsive to fluctuations in real income, followed by residential and total metered accounts. Commercial demand was unresponsive to real income. Both short-run and long-run elasticities are available from the partial adjustments model, and the time to reach 90% of the long-run response varies from three to eight years. (Author's abstract)
W91-05790

6E. Water Law and Institutions

LEGAL CONCEPTS IN WATER MANAGEMENT: SHAPING THE LAW TO SERVE THE PUBLIC INTEREST.
B. E. Griffith.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 5-26, 69 ref.

Descriptors: *Comprehensive planning, *Interagency cooperation, *Legal aspects, *Mississippi, *State jurisdiction, *Water resources management, Alluvial plains, Alluvial rivers, Long-term planning, Management planning, Water districts, Water management, Water quality management.

Increasing emphasis is being placed on comprehensive structures for state-level management, conservation, and long-range water resource planning. The State of Mississippi and the Mississippi Delta, utilizing water management concepts and models developed in the southeastern and western states, have recently organized the Yazoo-Mississippi Delta (YMD) Joint Water Management District to overcome fragmentation of water resource management on the state and local government levels. Numerous opportunities exist for the YMD Joint Water Management District to take the lead in water resource management, planning, research, and education in the areas of: water quality and contamination; surface water monitoring; research and technical assistance; chemical treatment and disease control; optimum water use studies; nonpoint source pollution control; pesticide container program; Mississippi River diversion; augmentation of water supplies; and wetlands protection and management. It is proposed that the YMD Joint Water Management District perform the following during its first year of operation: fund an evaluation of the chemical and physical properties of Delta surface water; set up the district staff; assist with alluvial aquifer water level measurements; assist with evaluation of water use and conservation practices in rice production; and evaluate the possibility of additional low water weirs on various small streams. Entities such as the YMD Joint Water Management District are in a position to undertake a program of systematic education coupled with qualitative and quantitative conservation, management, and long-term planning. (See also W91-05137) (Fish-PTT)
W91-05138

WHAT CAN YOU LEARN ABOUT WATER RESOURCES IN MOSCOW, U.S.S.R.
Florida Univ., Gainesville. Dept. of Civil Engineering.
J. V. Walters.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 120-121.

Descriptors: *Civil engineering, *Conferences, *Organizations, *Professional societies, *USSR, *Water resources management, Interdisciplinary studies, Wastewater treatment, Water quality, Water resources, Water supply, Water treatment.

During June, 1989, a small group of members of the American Society of Civil Engineers attended a three-day, bilateral, water quality conference in Moscow, the first joint conference sponsored by the Union of Scientific and Engineering Societies of the U.S.S.R. As might be anticipated in the U.S.S.R., their organizations have more central coordination than do professional societies in the U.S., which allows a greater ease in achieving interdisciplinarity in their considerations of subjects. The leading technologists have seen the need to reevaluate their techniques and procedures and to seek cooperative ties with their counterparts in other countries. The opening papers described the water supply perspectives of the two nations, followed by descriptions of representative municipal water supply systems for each of the countries. Water quality, water treatment systems, disinfection, problematic coagulative treatment, filtration practice, sludge management, surface water supplies, aquifer protection, artificial groundwater recharge and conjunctive use, water use rates, and water conservation practices next were addressed by speakers of both nationalities. The single most general conclusion possible from the information presented during the conference is that Soviets and Americans who deal with water resources management, water supply, and wastewater treatment face approximately the same problems and opportunities. The needs for quantity and quality and geographic incompatibilities of supply and demand in the two countries, as well as approaches to problem solutions, are very similar. Probably most of the variances of viewpoint derive from the vastly different ways that the two societies are organized to operate. (See also W91-05137) (Fish-PTT)
W91-05151

BRIEF REVIEW OF WATER RIGHTS IN NEW HAMPSHIRE.
New Hampshire Dept. of Environmental Services, Concord. Water Management Bureau.
K. Stern.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 2, p 149-152, June 1990.

Descriptors: *Legal aspects, *New Hampshire, *Water rights, *Legislation, *Administrative agencies, Governmental interrelations, Water use, Public trust doctrine, Groundwater, Instream flow.

There is increasing awareness and concern among water users over the status and security of their water rights. In New Hampshire, since the industrial revolution, the common law of riparian rights and reasonable use was the rule which applied to water use. Today, water rights can be established, challenged and limited in a variety of ways which contributes to uncertainty. The legislature as the ultimate custodian of the public interest can, at its own discretion alter, limit, or repeal rights exercised by citizens, municipalities, or businesses. The legislature can further convey its powers to administrative agencies for regulation and control of the flows in rivers and streams. The role of the courts, legislative appropriation, the public trust doctrine, groundwater, instream flows and actions of administrative agencies are also briefly reviewed. (Medina-PTT)
W91-05213

N. H. WATER RIGHTS: AN ENDANGERED SPECIES.
Manchester Water Works, NH.
D. Kittredge.
Journal of the New England Water Works Association JNEWA6, Vol. 104, No. 2, p 153-156, June 1990. 1 fig, 3 ref.

Descriptors: *New Hampshire, *Public trust doctrine, *Legislation, *Riparian rights, *Public waters, Governmental controls, Recreation facilities, Surface water, Legal aspects, Groundwater.

In August, 1989, the New Hampshire (NH) Attorney General decided that existing and proposed water withdrawals from Loon Pond for recreational snow making would be an unreasonable use of public waters held in trust by the State, a long established legal principle called the doctrine of public trust, and therefore legislative action would be required to permit future withdrawals. The opinion went further by suggesting that the NH Supreme Court might eventually adopt a rule which applies in other jurisdictions that water use for public distribution is outside the scope of riparian rights and thus requires legislative approval. One could say then that the existing doctrine of riparian rights has been challenged by the State and that the guiding principle of reasonable use may soon fall victim to a new legislation leading to increased governmental controls and possible allocation of water supplies throughout New Hampshire. This decision could conceivably lead to dramatic changes in the ability of water suppliers and others to withdraw water from surface and, by extension, even underground sources. This could signal a significant change in the principle of riparian rights as we now know them. (Medina-PTT)
W91-05214

ENVIRONMENTAL REGULATIONS PLACE NEW RESPONSIBILITIES ON PROPERTY OWNERS.
Environmental Realty Services, Nashville, TN.
For primary bibliographic entry see Field 5G.
W91-05237

PROVIDING ENVIRONMENTAL IMPAIRMENT LIABILITY INSURANCE COVERAGE.
Environmental Insurance Management, Inc., McLean, VA.
For primary bibliographic entry see Field 5G.
W91-05238

IMPLICATIONS OF DEALING WITH REAL ESTATE-BASED CLEANUP STATUTES.
Nixon, Hargrave, Devans and Doyle, Albany, NY.
J. L. Greenthal, and M. P. Millspaugh.
IN: Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies. Lewis Publishers, Chelsea, Michigan. 1989. p 17-27, 1 tab, 21 ref.

Descriptors: *Cleanup operations, *Legislation, *Real estate, *Legal aspects, *Regulations, Environmental protection, Management planning.

The government is attempting to control and remedy environmental contamination by enacting statutes and regulations which have a profound and wide reaching effect. In turn, a number of market forces are acting to impose further controls on industry's actions relative to environmental contamination. Although there are pros and cons concerning both statutory and market controls, it is evident that both will continue to work on business and real estate transactions. Corporate policies and management practices which stress preventive maintenance and proper environmental housekeeping will substantially reduce economic and operational disruptions when the time comes to transfer or sell an industrial facility. It is also crucial that all parties to transactions involving real estate be aware of the condition and extent of contamination at a site, an awareness achieved only through the performance of environmental audits and assessments of property before transactions are finalized. Undertaking and completing these types of protective and preventive measures will minimize the disruption caused by environmental contamination. (See also W91-05236) (Lantz-PTT)
W91-05239

STATE OF RESEARCH AND REGULATORY APPROACH OF STATE AGENCIES FOR CLEANUP OF PETROLEUM CONTAMINATED SOILS.
Massachusetts Univ., Amherst. Environmental and Health Sciences Program.
For primary bibliographic entry see Field 5G.
W91-05244

COUNCIL FOR HEALTH AND ENVIRONMENTAL SAFETY OF SOILS (CHESS): A COALITION TO STANDARDIZE APPROACHES TO SOIL CONTAMINATION PROBLEMS.
Massachusetts Univ., Amherst. Environmental and Health Sciences Program.
For primary bibliographic entry see Field 5G.
W91-05267

PREFERRED ALTERNATIVE USES OF WATER RESOURCES: VIEWS OF ENVIRONMENTAL ACTIVISTS IN THE U.S. VIRGIN ISLANDS.
Nevada Univ., Las Vegas. Dept. of Political Science.
For primary bibliographic entry see Field 6D.
W91-05613

CALIFORNIA LAND BAN OF METAL-CONTAINING AQUEOUS WASTES.
California Dept. of Health Services, Sacramento. Alternative Technology Section.
For primary bibliographic entry see Field 5G.
W91-05672

IMPLEMENTATION OF A HEAVY METALS REDUCTION PROGRAM IN THE CITY OF LOS ANGELES.
Los Angeles City Bureau of Sanitation, CA.
For primary bibliographic entry see Field 5G.
W91-05673

REGULATORY REQUIREMENTS FOR POINT-OF-USE SYSTEMS.
Environmental Protection Agency, Washington, DC. Office of Pesticides and Toxic Substances.
For primary bibliographic entry see Field 5F.
W91-05696

CONTROL OF POINT-OF-USE WATER TREATMENT DEVICES IN CANADA: LEGAL AND PRACTICAL CONSIDERATIONS.
Environmental Health Directorate, Ottawa (Ontario).
For primary bibliographic entry see Field 5F.
W91-05697

REGULATION OF WATER TREATMENT DEVICES IN CALIFORNIA.
For primary bibliographic entry see Field 5F.
W91-05698

WISCONSIN REGULATION OF POINT-OF-USE AND POINT-OF-ENTRY WATER TREATMENT DEVICES.
Wisconsin Dept. of Industry, Labor and Human Relations, Madison.
For primary bibliographic entry see Field 5F.
W91-05699

FEDERAL TRADE COMMISSION REGULATION OF WATER TREATMENT DEVICES.
Federal Trade Commission, Washington, DC.
For primary bibliographic entry see Field 5F.
W91-05701

POU/POE PRODUCT PROMOTION GUIDELINES AND CODE OF ETHICS.
Water Quality Association, Lisle, IL.
For primary bibliographic entry see Field 5F.
W91-05702

NSF'S LISTING PROGRAM FOR POU/POE DWTUS.
National Sanitation Foundation, Ann Arbor, MI.
For primary bibliographic entry see Field 5F.
W91-05703

WATER QUALITY ASSOCIATION VOLUNTARY PRODUCT VALIDATION PROGRAM AND VOLUNTARY CERTIFICATION PROGRAM.
Water Quality Association, Lisle, IL.
For primary bibliographic entry see Field 5F.
W91-05704

GUIDE STANDARDS AND PROTOCOL FOR TESTING MICROBIOLOGICAL WATER PURIFIERS.
Army Biomedical Research and Development Lab., Fort Detrick, MD.
For primary bibliographic entry see Field 5F.
W91-05705

6G. Ecologic Impact Of Water Development

EXTENDING THE CAPABILITY OF THE COMPONENT INTERACTION MATRIX AS A TECHNIQUE FOR ADDRESSING SECONDARY IMPACTS IN ENVIRONMENTAL ASSESSMENT.
Cape Town Univ. (South Africa). Dept. of Environmental and Geographical Science.
J. Shopley, M. Sowman, and R. Fuggle.
Journal of Environmental Management JEVMAW, Vol. 31, No. 3, p 197-213, October 1990. 5 fig, 3 tab, 21 ref.

Descriptors: *Component Interaction Matrix, *Environmental effects, *Environmental impact, *Water resources development, Computer programs, Project planning.

The component interaction technique has been developed to structure a preliminary investigation of secondary impacts during the initial phase of environmental impact assessments. The technique is based on the component interaction matrix, where the environment is modeled as a list of components, and direct dependencies between these components are then recorded. Computerized matrix powering procedures are employed to structure the data to facilitate an investigation of the secondary impact potential in the system. Chains of dependents between components can be traced, and components ranked in order of their ability to initiate secondary impacts or their susceptability to secondary impacts. The procedures essential to the definition of the component interaction matrix ensure that the preliminary analysis of secondary impacts is based on a comprehensive and structured consideration of the environment. The technique is designed to compliment the use of any of a wide range of impact analysis methods currently employed, but which are unable to consider secondary impacts. (Lantz-PTT)
W91-04965

ENVIRONMENTAL HEALTH.
P. Ramayya Naidu.
Indian Journal of Public Health IPBHAH, Vol. 32, No. 2, p 70-81, April/June 1988.

Descriptors: *Air pollution, *Environmental quality, *Resources management, *Water pollution, *Water pollution sources, Human population, India, Industrial wastewater, Irrigation effects, Land resources, Nonpoint pollution sources, Public health, Soil erosion, Urbanization, Wastewater pollution, Water pollution effects, Water resources, Waterlogging.

A keynote address on environmental health in India was presented. Environmental problems in India were classified in the following areas: (1) land management, (2) water management, including marine and coastal waters, (3) ambient air quality/air pollution control, (4) noise pollution, (5) population planning, and (6) environmental education. The major threats to land resources in India are ascribed to waterlogging, salinization and soil erosion. Wastes that contribute to water pollution are sewage and industrial wastes (point sources) and agricultural and dairy waste and runoff (nonpoint sources). Public health problems associated with irrigation in India are malaria, filariasis and fluorosis. A safe public water supply is seen as the foundation for economic progress in India. It is estimated that 30% of mortality and 50% of morbidity due to infectious diseases in India is due to water borne diseases. Important air pollutants in the country are particulates, sulfur oxides, carbon monoxide, nitrogen dioxide, hydrocarbons, fluorine, radioactive nuclides and carbon dioxide. By the year 2000, India will have an estimated 1000 million inhabitants, 33% of which will be living in urban areas, creating an increased demand for resources and increasing pollution levels. It is recommended that environmental education be promoted at all levels of social structure and not merely restricted to the general public in the form of mass education. (MacKeen-PTT)
W91-05051

EFFECTS OF CLEARING AND SNAGGING ON PHYSICAL CONDITIONS OF RIVERS.
Memphis State Univ., TN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W91-05141

TENNESSEE-TOMBIGBEE WATERWAY CANAL SECTION EFFECT ON ADJACENT BOTTOMLAND HARDWOODS.
Soil Conservation Service, Jackson, MS.
R. L. Ulmer.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 92-97, 3 fig, 8 ref.

Descriptors: *Bottomland, *Canals, *Environmental impact, *Flood plain management, *Forest hydrology, *Tennessee, Alluvial aquifers, Artesian head, Clays, Groundwater level, Moisture tension, Piezometers, Plant growth, Seasonal variation, Soil water, Tensiometers.

Landowners, environmentalists, and project management personnel have all expressed concern as

to what effect the Tennessee-Tombigbee Waterway Canal Section, with its operating water level above the adjacent flood plain surface, would have on the bottomland hardwoods. A seven-year (1982-1989) study was made in the bottomland hardwood plain to measure the alluvial aquifer levels, the groundwater levels, the soil moisture, and the vegetative growth. Measurements were made once monthly to track seasonal changes distinguished from pre-pool and post-pool changes using piezometers, tensiometers, soil moisture blocks, and a nuclear moisture probe. The pre-pool alluvial piezometer water levels clearly show a seasonal wet/dry summer pattern which is continued at the higher post-pool levels. The soil moisture tension and total soil moisture values continue the seasonal fluctuations during both pre-pool and post-pool periods. The Canal pool influence extends from about 1000 feet to 1500 feet outside the Canal levee centerline, typical for dry and wet periods, respectively. The influence appears to be diminished, due to aquifer material resistance, to about 1.0 foot of additional artesian head at the 1300-foot distance, about 0.5 foot below natural ground. The clay soil material supporting the vegetative growth is about 10 feet thick, providing an effective barrier against the alluvial artesian pressure influencing vegetative growth. Piezometers show that vegetative consumptive use is greater than water movement through the soil. The continued measurements from 1982-1989 show normal growth rates for the selected trees. It is concluded that there is no impact and, therefore, no vegetative changes caused by the Canal impoundment. (See also W91-05137) (Fish-PTT)
W91-05147

UPSTREAM EXTENT OF SALINE WATER IN THE PASCAGOULA RIVER.
R. A. Rebich, and M. N. Landers.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 98-104, 5 fig, 4 ref.

Descriptors: *Estimating equations, *Mississippi, *Pascagoula River, *Saline water intrusion, *Saline-freshwater interfaces, *Tidal rivers, *Water resources development, Least squares method, Mathematical equations, Regression analysis, River mouth, Runoff-salinity relationships, Surface water availability, Water supply development.

Rapid development of the groundwater resources in the Mississippi Gulf Coast region has caused long-term declines in both water levels and water quality. As a consequence, the development of a surface water supply has been proposed to help meet future demands of the Pascagoula-Moss Point metropolitan area. The surface water source that has the greatest potential for development is the Pascagoula River. The lower reach of the river is tidally affected and has a fairly typical 'wedge' of saline water intrusion from the Mississippi Sound. A multiple least squares regression equation can be used to estimate the upstream extent of saline water in the lower Pascagoula River, information that would be helpful to water resources planners and managers. This equation can be used in evaluations of the potential development of the Pascagoula River as a surface water supply. The two significant explanatory variables are salinity at the mouth of the river and the 7-day average discharge. Tide stage and direction, temperature, and Escatawpa River inflow were not statistically significant to the location of the upstream extent of saline water. The maximum extent of salinity was estimated to be 17 miles upstream of the mouth of the Pascagoula River using the equation and extreme values of the explanatory variables (high salinity in the river mouth and 7-day, 10-year low flow). (See also W91-05137) (Fish-PTT)
W91-05148

INFLUENCE OF GREENTREE RESERVOIR MANAGEMENT ON OVERSTORY COMPOSITION, CANOPY DENSITY, AND HARDWOOD REGENERATION ON NOXUBEE NATIONAL WILDLIFE REFUGE.
Mississippi State Univ., Mississippi State. School of Forestry.
G. L. Young, B. L. Karr, J. D. Hodges, B. D. Leopold, and R. M. Kaminski.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 105-115, 1 fig, 4 tab, 31 ref.

Descriptors: *Bottomland, *Flood plain management, *Forest management, *Mississippi, *Reservoir operation, *Wildlife habitats, Canopy, Oak trees, Seedlings, Species composition, Vegetation effects, Waterfowl.

Greentree reservoirs (GTRs) are modified bottomland forest sites at least partly enclosed by a system of levees which serve to impound water between late fall and early spring. These reservoirs are primarily managed for migrating waterfowl, particularly mallards and wood ducks. The dramatic decrease in Mississippi's bottomland acreage and drainage and flood control projects have reduced the availability of this waterfowl habitat, in the form of floral compositional changes and plant cover loss. Maintaining desirable tree species composition within these modified bottomland hardwood sites is crucial to the long-term productivity of these areas. Managers of Noxubee National Wildlife refuge (NNWR) are concerned that 30 years of annual flooding in two of their GTRs may be causing a shift in composition toward water tolerant oak species. Tree-species composition (relative frequency, relative density, and relative dominance of each species) within the two GTRs and a control area was sampled using the point-center quarter method. It was found that community structure has been modified as a result of GTR management. Shifts toward increased dominance by overcup oak were evident in the overstory and in seedling regeneration. Canopy density has been reduced resulting in a discontinuous and nonuniform canopy appearance. A marked decrease in saplings and a substantial increase in the number of seedlings have also occurred. Existing data are insufficient to evaluate the current 2-year flooding cycle now being practiced. Current water management should allow for greater soil aeration and consequently increased tree vigor. (See also W91-05137) (Fish-PTT)
W91-05149

GLOBAL CLIMATE CHANGE: POLICY IMPLICATIONS FOR FISHERIES.
NSI Technology Services Corp., Corvallis, OR.
For primary bibliographic entry see Field 8I.
W91-05167

CONSERVATION STATUS OF THREATENED FISHES IN WARNER BASIN, OREGON.
Bureau of Land Management, Washington, DC. Wildlife and Fisheries Div.
J. E. Williams, M. A. Stern, A. V. Munhall, and G. A. Anderson.
Great Basin Naturalist GRBNAR, Vol. 50, No. 3, p 243-248, October 1990. 1 fig, 1 tab, 13 ref.

Descriptors: *Endangered species, Water resources development, Irrigation, *Oregon, *Fish conservation, *Population density, Reservoirs, Dams, Foskett speckled dace, Warner sucker, Crappie, Bullhead, Lentic environment.

Two federally listed fishes, the Foskett speckled dace and Warner sucker, are endemic to Warner Basin in central Oregon. The Foskett speckled dace is native only to a single spring in Coleman Valley. A nearby spring was stocked with dace in 1979 and 1980, and now provides a second population. The numbers of dace probably are at their highest levels since settlement of the region. The Warner sucker historically occurred throughout much of the Warner Valley, but its distribution and abundance have been reduced by construction of reservoirs and irrigation dams and the introduction of predatory game fishes. Lentic habitats have become dominated by introduced fishes, particularly white crappie, black crappie, and brown bullhead. The largest remaining population of Warner suckers occurs in Hart Lake, where successful reproduction was documented but there is no evidence of recruitment to the adult population. (Author's abstract)
W91-05203

MICROBIAL POPULATIONS OF A SOUTHERN CHERNOZEM AS AN INDICATOR OF IRRIGATION EFFECTS.
Moscow State Univ. (USSR). Dept. of Soil Science.
For primary bibliographic entry see Field 3F.
W91-05217

EFFECT OF SIBERIAN RESERVOIRS ON THE ENVIRONMENT.
For primary bibliographic entry see Field 4A.
W91-05302

IMPACT OF MAN.
Johns Hopkins Univ., Baltimore, MD.
For primary bibliographic entry see Field 4C.
W91-05872

7. RESOURCES DATA

7A. Network Design

PROBABILISTIC SOIL CONTAMINATION EXPOSURE ASSESSMENT PROCEDURES.
Environmental Defense Fund, Austin, TX.
For primary bibliographic entry see Field 5A.
W91-05326

OPTIMAL CONFIGURATION AND SCHEDULING OF GROUND-WATER TRACER TEST.
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-05789

'WHERE'S THE BENZENE': EXAMINING CALIFORNIA GROUND-WATER QUALITY SURVEYS.
Applied Science and Engineering, Inc., Davis, CA.
For primary bibliographic entry see Field 5B.
W91-05818

CRITIQUE OF THE CLIMATIC RECORD OF 'WATER EQUIVALENT OF SNOW ON THE GROUND' IN THE UNITED STATES.
Kent State Univ., OH. Dept. of Geography.
For primary bibliographic entry see Field 2C.
W91-05859

7B. Data Acquisition

IDENTIFICATION OF THE BOUNDARIES BETWEEN TWO WATERSHEDS IN A VOLCANIC AREA BY THE SELF-POTENTIAL METHOD (VERIFICATION DE LIMITES DE NAPPES AQUIFERES EN TERRAIN VOLCANIQUE PAR LA METHODE DE POLARISATION SPONTANEE).
Observatoire de Physique du Globe de Clermont-Ferrand (France).
For primary bibliographic entry see Field 2F.
W91-04939

INFLUENCE OF MODE OF EXPOSURE AND THE PRESENCE OF A TUBICULOUS POLYCHAETE ON THE FATE OF BENZ(A)ANTHRACENE IN THE BENTHOS.
Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 5B.
W91-04945

STABILITY OF VOLATILE ORGANIC COMPOUNDS IN ENVIRONMENTAL WATER SAMPLES DURING TRANSPORT AND STORAGE.

Oak Ridge National Lab., TN. Analytical Chemistry Div.
For primary bibliographic entry see Field 5A.
W91-04947

DISTINGUISHING DIPHENYLAMINE AND N-NITROSODIPHENYLAMINE IN HAZARDOUS WASTE SAMPLES BY USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY/THERMOSPRAY/MASS SPECTROMETRY.
Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W91-04956

ASSESSMENT OF PERFORMANCE OF WET ATMOSPHERIC DEPOSITION SAMPLERS. PART 2. VALIDATION OF SITING CRITERIA.
Military Academy, West Point, NY. Science Research Lab.
R. C. Graham.
Water, Air and Soil Pollution WAPLAC, Vol. 52, No. 1/2, p 97-114, 1990. 8 fig, 12 tab, 9 ref. USGS Agreement No. WRD-4000-4352-84.

Descriptors: *Acid rain, *Instrumentation, *Network design, *Performance evaluation, *Samplers, *Site selection, *Wet deposition, Chemical analysis, Dry deposition, Hydrogen ion concentration, Measuring instruments, Specific conductivity, Statistical analysis.

The variability in performance of 4 wet/dry atmospheric deposition samplers were compared for 1 year. Samples were collected weekly and analyzed for pH, specific conductance, common ionic chemical constituents, and sample mass. Differences in the results between collectors were interpreted in terms of violations of siting criteria. Several of the criteria used in siting collectors for the National Atmospheric Deposition Program/National Trends networks were purposely compromised to determine the effects of such criteria on the validity of samples collected at sites where the location of samplers violates accepted siting criteria. The study showed that items should be excluded within a 45 degree cone of the sampler and also items of sufficient bulk to disturb wind patterns should be excluded within 5 m of the sampler. The non-normal distribution of residuals from a parametric analysis of variance of the data set necessitated the application of the nonparametric Friedman test to assess comparability of chemical deposition and volume between and within samplers. Statistically significant differences existed for most comparisons, however the test does not permit quantification of their magnitudes, although general trends may be determined. The major factor that appears to control differences in deposition is the collection efficiency of a sampler. (Lantz-PTT)
W91-04972

DNA DAMAGE DETERMINATION BY THE ALKALINE ELUTION TECHNIQUE IN THE HAEMOLYMPH OF MUSSEL MYTILUS GALLOPROVINCIALIS TREATED WITH BENZO(A)PYRENE AND 4-NITROQUINOLINE-N-OXIDE.
Institut Rudjer Boskovic, Rovinj (Yugoslavia). Centar za Istrazivanje Mora.
For primary bibliographic entry see Field 5C.
W91-04991

EFFICIENCY ESTIMATES OF A STREAM BENTHOS SUCTION SAMPLER.
Murdoch Univ. (Western Australia). School of Biological and Environmental Sciences.
I. O. Growns.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 5, p 621-626, 1990. 1 fig, 2 tab, 14 ref.

Descriptors: *Benthic sampling, *Instrumentation, *Measuring instruments, *Performance evaluation, *Samplers, *Sampling, Boulton Suction Sampler, Macroinvertebrates, Organic matter.

The efficiency of a modified Boulton suction sampler was tested in two riffle zones, using multiple removals. Macroinvertebrate fauna was sampled with approximately 70% efficiency on first removal, while organic matter was sampled with 55% efficiency. Sampling efficiencies for specific taxa ranged from 86% (Plecoptra) to 66% (Chironomidae) and 59% (Trichoptera). The results of this study indicate that sampling efficiency can be improved either by taking multiple samples at one location or by increasing the time spent disturbing the substratum and pumping water from the stand pipe. The results also indicate the importance of conducting pilot studies to determine the efficiency of a sampler at sites where the efficiency is likely to be different. (Author's abstract)
W91-05006

USE OF SEDIMENT BAGS AS A MONITOR OF FECAL POLLUTION IN STREAMS.
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
For primary bibliographic entry see Field 5A.
W91-05008

SEASONAL LETHALITY OF PENTACHLOROPHENOL TO JUVENILE ATLANTIC SALMON.
Department of Fisheries and Oceans, St. Andrews (New Brunswick). Biological Station.
For primary bibliographic entry see Field 5C.
W91-05011

AMINO ACID SEQUENCE OF CADMIUM-BINDING PEPTIDE INDUCED IN A MARINE DIATOM, PHAEODACTYLUM TRICORNUTUM.
Hokkaido Univ., Sapporo (Japan). Research Inst. of North Pacific Fisheries.
For primary bibliographic entry see Field 5B.
W91-05012

MONITORING RIVER ICE WITH LANDSAT IMAGES.
Cold Regions Research and Engineering Lab., Hanover, NH. Geological Sciences Branch.
For primary bibliographic entry see Field 2C.
W91-05031

ASSESSMENT OF VEGETATION AND SOIL WATER REGIMES IN PARTIAL CANOPIES WITH OPTICAL REMOTELY SENSED DATA.
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 2G.
W91-05032

METHODS FOR DETERMINING ASSIMILABLE ORGANIC CARBON AND SOME FACTORS AFFECTING THE VAN DER KOOIJ METHOD.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-05058

PHOSPHATE-SENSITIVE ENZYME ELECTRODE: A POTENTIAL SENSOR FOR ENVIRONMENTAL CONTROL.
Lyon-1 Univ., Villeurbanne (France). Lab. de Genie Enzymatique.
E. M. d'Urso, and P. R. Coulet.
Analytica Chimica Acta ACACAM, Vol. 239, No. 1, p 1-5, November 23, 1990. 5 fig, 16 ref.

Descriptors: *Analytical methods, *Electrodes, *Instrumentation, *Phosphates, *Pollutant identification, *Sensors, *Water quality monitoring, Detection limits, Enzymes, Eutrophication, Ion-selective electrodes, Measuring instruments, Water analysis.

A highly selective enzyme electrode was designed for the assay of phosphate ions. A bienzyme membrane with co-immobilized nucleoside phosphorylase and xanthine oxidase was used with a platinum amperometric electrode for the detection of enzymatically generated hydrogen peroxide. A detection limit of 100 nM was obtained. The calibration graph was linear for phosphate concentrations between 0.1 and 10 microM, the range of interest for environmental analysis. A relative standard deviation of 4% was obtained for ten replicate assays of 1 microM potassium dihydrogen phosphate. Analysis of phosphate solutions prepared in seawater indicated a sensitivity 85% of that obtained for solutions in distilled water. About 70% of the initial sensitivity of the electrode remained after 20 h of use. In preliminary experiments a very low response was obtained with solutions of tripolyphosphate, a compound used in many detergents and which is partly responsible for eutrophication. It is concluded that the phosphate sensitive enzyme electrode may be useful for assays of polluted waters. (MacKeen-PTT)
W91-05090

DYNAMIC RESPONSE OF AUTOMATIC WATER-LEVEL CONTROLLER: I. THEORY.
Wuhan Inst. of Hydraulic and Electric Power Engineering (China).
For primary bibliographic entry see Field 3F.
W91-05131

DYNAMIC RESPONSE OF AUTOMATIC WATER-LEVEL CONTROLLER: II. APPLICATION.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3F.
W91-05132

RATING CORRECTION FOR LATERAL SETTLEMENT OF PARSHALL FLUMES.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. R. Abt, and K. J. Staker.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 6, p 797-803, November/December 1990. 1 fig, 1 tab, 11 ref.

Descriptors: *Discharge measurement, *Errors, *Flow rates, *Instrumentation, *Rating flumes, Accuracy, Comparison studies, Correction factors, Parshall flumes, Performance evaluation.

Various factors can lead to settling of Parshall flumes made of conventional materials and installed where they are subject to freezing and thawing cycles. Work in the early 1970s showed that settling could lead to errors of 1-76% for free flow and 1-66% for submerged flow conditions. A study was conducted to determine how lateral, or transverse, settlement of a Parshall flume influences the accuracy of discharge measurements for free-flow conditions. A 3-in Parshall flume was installed in a channel and flow rates were measured with lateral flume crest slopes of 0, 3.6, 6.5, 9.0, 13.3, -3.8, -4.8, -7.2, and -11.8%. The apparent discharge was compared to the measured discharge for each slope with free outfall conditions. The results indicate that the Parshall flume accuracy is in error approximately 7% at a lateral slope of +or-10%. The flow measurement requires a 0.75% adjustment for each 1% of lateral settlement at the flume crest. A method for correcting the apparent discharge with the measured discharge is presented for variable lateral slope conditions. (Rochester-PTT)
W91-05133

ANALYSES OF ADSORPTION KINETICS USING STIRRED-FLOW CHAMBER: II. POTASSIUM-CALCIUM EXCHANGE ON CLAY MINERALS.
Delaware Univ., Newark. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 2K.
W91-05179

PORTABLE LASER SCANNER FOR MEASURING SOIL SURFACE ROUGHNESS.
National Soil Erosion Lab., West Lafayette, IN.
For primary bibliographic entry see Field 2J.
W91-05186

WICK TENSIOMETER TO MEASURE LOW TENSIONS IN COARSE SOILS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2G.
W91-05188

VOLUME RECORDER FOR LYSIMETER WATERS.
Great Lakes Forestry Research Centre, Sault Sainte Marie (Ontario).
For primary bibliographic entry see Field 2G.
W91-05189

ICA SYMPOSIUM ON INSTRUMENTATION, CONTROL AND AUTOMATION IN WATER AND WASTEWATER MANAGEMENT.
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W91-05281

FLOW MONITORING SYSTEM FOR THE VAAL AND WILGE RIVERS.
Department of Water Affairs, Pretoria (South Africa).
R. A. Chantler.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 18-24.

Descriptors: *Streamflow, *Flood warning systems, Water supply, *South Africa, *Telemetry, *Flow measurement, *Flood forecasting, Reservoirs, Vaal Dam, Design criteria, Resource management.

Vaal Dam is a vital component in the water supply system of the Pretoria-Witwatersrand-Vereeniging region in South Africa and has a full storage capacity of 2,529 cu m. Water for the Vaal Dam is collected by the Vaal and Wilge rivers. A telemetry system was designed primarily to provide early warning of conditions that may cause a flood and thereafter to provide an accurate record of the situation existing at various points in the catchment area. The system also provides water flow statistics and assists with day-to-day resource management. The information collected is used to perform flood routing by taking the hydrographs obtained from the various river measuring stations and forecasting the propagation of the flood wave to the stations further downstream. A total of 15 river measuring stations are placed at carefully selected positions along the rivers and major tributaries, with 7 stations in the Vaal river area, 5 stations in the Wilge River area, and 3 stations covering the river downstream of Vaal Dam. All telemetry stations are of the intelligent type using microprocessors. Each outstation provides water level as well as river flow readings. Flow is calculated from level readings using floating point arithmetic and conversion formulae with 5 sets of conversion constants, all down-loadable from the Pretoria or Vaal Dam master stations. The major source of power for the outstations and repeater stations is solar power, and extensive steps were taken to limit damage caused by lightning and other static discharges. By properly integrating all subsystems into a well engineered network, a reliable telemetry system was produced to fulfill the requirements laid down at the planning stage. (See also W91-05281) (White-Reimer-PTT)
W91-05282

CONTINUOUS WATER QUALITY MONITORING.
South Africa Dept. of Water Affairs, Pretoria. Water Pollution Control Directorate.
For primary bibliographic entry see Field 5G.
W91-05287

CONFIGURATION OF COMPUTER BASED CONTROL SYSTEMS FOR WASTEWATER TREATMENT PLANTS.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-05288

GAS METERING AT SEWAGE PURIFICATION WORKS.
Stewart, Sviridov and Oliver, Marshalltown (South Africa).
For primary bibliographic entry see Field 5D.
W91-05291

DATA CAPTURE SYSTEMS AT THE JOHANNESBURG NORTHERN WORKS.
Johannesburg City Health Dept. Labs. (South Africa).
For primary bibliographic entry see Field 5D.
W91-05292

COMPUTERISED INSTRUMENTATION AND CONTROL SYSTEMS.
Lektratek Marketing, P.O. Box 1257, Rivenia 2128, South Africa.
A. Sugden, and H. J. Els.
IN: ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management. Program and summaries of the symposium held 19 November 1987, CSIR Conference Centre, Pretoria, South Africa. Report No. S467, (1987). p 76-78.

Descriptors: *Control systems, *Measuring instruments, *Water quality monitoring, Flow control, Flow measurements, Varied flow, *Instrumentation, *Automation, *Wastewater facilities, Monitoring, Computers, Economic aspects.

In recent years, with the advent of electronics, modern instruments have become more compact, versatile, and multi-purpose. The latest development is the Lektratek MONITA which is a computerized multi-purpose instrument for water quality data logging, level/flow measurement and controlling purposes. In addition to the various individual functions, and because it is programmable, the MONITA is able to carry out a number of parameter measurements, perform calculations and then control mechanical equipment to ensure that the final water or effluent quality is within certain limits. This system was installed at a wastewater treatment works in an open channel between the biological filters and the final settling tanks. The biological filters were controlled by dosing siphons and the flow patterns measured in the open channel could be described as 'erratic' due to these circumstances. Because of the variable flow patterns and the addition of two chemicals, the MONITA had to be carefully programmed and finely tuned for this installation. After the initial problems, due to the variations in flow rates, the system has worked well. The system is proving to be cost effective as only the required amount of chemicals are being used to ensure that the pH levels of the effluent are being maintained within the predetermined limits. (See also W91-05281) (White-Reimer-PTT)
W91-05293

CONDUCTIVITY AS A MEANS OF CONTROL ON THE DEMINERALISATION PLANT AT MATIMBA POWER STATION.
Electricity Supply Commission, Johannesburg (South Africa). Engineering Investigations Div.
For primary bibliographic entry see Field 5F.
W91-05299

COMPARISON OF SERUM BOTTLE TOXICITY TEST WITH OECD METHOD.
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05322

GAS-TRANSFER MEASUREMENTS USING HEADSPACE ANALYSIS OF PROPANE.
Harza Engineering Co., Chicago, IL.
J. R. Thene, and J. S. Gulliver.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1107-1124, November/December 1990. 5 fig, 6 tab, 19 ref. National Science Foundation, Environmental Program, Grant ECE-861 5279.

Descriptors: *Air-water interfaces, *Path of pollutants, Uncertainty, *Environmental engineering, *Oxygen transfer, *Analytical methods, *Water chemistry, *Gas chromatography, Propane, Wastewater disposal, Tracers, Wastewater management, Laboratory methods, Dissolved oxygen.

Environmental gas transfer is the exchange of chemicals between the gaseous phase in the atmosphere and the dissolved phase in a water body, as in the reaeration or dissolved oxygen (DO) transfer from the atmosphere to rivers in order to allow a river to assimilate waste loads from wastewater treatment facilities. Direct measurement of oxygen transfer in rivers is not often possible because of the interference of other in-stream processes affecting DO transfer, and because of the large uncertainties when DO approaches saturation concentrations. A sampling and analysis procedure for the tracer measurement of gas transfer has been developed. Dissolved propane was used as a gas-transfer tracer. The propane samples were analyzed by a headspace gas chromatographic technique that was tested as an alternative to the purge-and-trap technique previously used for tracer measurements. Headspace analysis is simple, fast, precise, and does not require the extensive apparatus required by the purge-and-trap technique, so that any gas-chromatography laboratory can perform the analysis. Headspace analysis was found to give excellent results with low uncertainty and a low limit of detection (0.15 micrograms/L). Gas-transfer measurements were performed on flow across a large-scale laboratory weir. A detailed uncertainty analysis was conducted for the transfer measurements; headspace analysis resulted in an average uncertainty of 0.0056, or approximately 1.4%, in terms of transfer efficiency. The results are applicable to other tracer measurements of gas transfer, and the headspace technique may be applied, with modifications, for the laboratory analysis of any volatile compound. (Fish-PTT)
W91-05324

MONITORING AND CONTROL OF BIOLOGICAL REMOVAL OF PHOSPHORUS AND NITROGEN BY FLOW-INJECTION ANALYSERS IN A MUNICIPAL PILOT-SCALE WASTEWATER TREATMENT PLANT.
Technical Univ. of Denmark, Lyngby. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-05331

DEVELOPMENT AND USE OF AN ELECTRICAL RESISTIVITY CONE FOR GROUNDWATER CONTAMINATION STUDIES.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W91-05358

ELECTROMAGNETIC PROFILING FOR GROUNDWATER IN PRECAMBRIAN BASEMENT COMPLEX AREAS OF NIGERIA.
Ibadan Univ. (Nigeria). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-05384

USE OF LYSIMETERS TO ESTIMATE LEACHING OF PESTICIDES IN AGRICULTURAL SOILS.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Water Management.
L. Bergstrom.
Environmental Pollution ENPOEK, Vol. 67, No. 4, p 325-347, 1990. 4 fig, 84 ref.

Descriptors: *Agricultural chemicals, *Analytical methods, *Leaching, *Lysimeters, *Path of pollutants, *Pesticides, *Reviews, Agricultural runoff, Experimental design, Percolation, Soil properties, Soil types, Water pollution sources.

Different aspects concerning soil-filling techniques, lysimeter size and materials, and drainage-system types are reviewed. The type of lysimeter used is determined by the type of measurements to be made and the degree of precision required. For example, short term evapotranspiration studies would require hourly monitoring and a sensitivity of 0.05mm of water, whereas 1mm and weekly monitoring are sufficient for long term water balance studies. In pesticide leaching studies, it is important to control all the water percolating through the soil profile. The bioactivity of many pesticides is strongly coupled to pH, soil temperature, texture, etc. and the physical conditions of an isolated soil under study will have a major influence on the outcome of results. Since repacked lysimeters, though adequate for sandy soils, are unacceptable for well-aggregated and stratified soils, an undisturbed soil monolith may be prepared by pushing a lysimeter casing into the ground and then digging around the outside of the casing. In pesticide studies, the surface area of the lysimeter should be at least 0.05 square meters to reduce the effects of sidewall flow and approximately 1 m in depth and all materials used should be non-sorptive with regard to pesticides being tested. At least two soil types, sand and clay, should be represented, and soils with extreme pH values (<5 and >8) should be avoided. Prior to treatment with pesticides, lysimeters should be watered until leachate is observed in the collection vessel in order to standardize results. Pesticide concentrations reached in lysimeter percolate represent levels which under natural conditions are typical of water leaving the root zones and ultimately reaching a river, lake or groundwater reservoir. (Doyle-PTT)
W91-05389

MEANINGFUL ENVIRONMENTAL DATA: NOT JUST THE LABORATORY'S RESPONSIBILITY.
Hart Environmental Management Corp., Albany, NY.
D. C. Anne.
Florida Scientist FLSCAQ, Vol. 53, No. 4, p 297-301, Autumn 1990. 14 ref.

Descriptors: *Data collections, *Environmental data, *Environmental policy, *Laboratory methods, *Precision, *Sampling, Data interpretation, Experimental design, Monitoring, Statistical methods, Testing procedures.

Increased federal and state environmental legislation has increased the need for environmental investigative, monitoring and clean-up programs. More consultants and analytical laboratories are entering the environmental market to meet the demand for assistance in answering questions and solving problems. Obtaining samples, maintaining sample integrity, and accurate sample analysis are critical to any environmental program that generates analytical data. In order to judge quality, validity, and reliability of both the sampling effort and the laboratory analysis, five aspects of meaningful environmental data should be addressed: comparability, representativeness, precision, accuracy and completeness. To ensure comparability, historical environmental data must be reviewed and the parameters to be used in sampling should be decided upon. Once a program has been established for sampling, the variables should be kept to a minimum. Sampling and analytical procedures should remain consistent throughout the history of the project so that later data may be effectively compared with earlier data. The population of interest must be represented without bias. A field log book should be kept to record sample location and weather conditions at the time of sample collection. A properly prepared chain-of-custody form must accompany all environmental samples collected so that a written record can be used to trace possession and holding of samples from the time of collection through sample analysis and data reporting. The third and fourth aspects of environmental data, precision and accuracy, are typically used to describe analytical data and are the primary responsibility of the laboratory. Accuracy is routinely assessed by means of spiked samples and reference materials. Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision is assessed by means of duplicate/replicate analyses. Data completeness involves ensuring that all the necessary sampling and analytical requirements are met. (Geiger-PTT)
W91-05410

METHOD FOR DETERMINING VOLATILE ORGANIC SOLVENTS IN CHALK PORE WATERS (SOUTHERN AND EASTERN ENGLAND) AND ITS RELEVANCE TO THE EVALUATION OF GROUNDWATER CONTAMINATION.
British Geological Survey, Wallingford (England). Hydrogeology Research Group.
For primary bibliographic entry see Field 5A.
W91-05417

CHECKS ON THE MEASUREMENT OF POTENTIAL EVAPOTRANSPIRATION USING WATER BALANCE DATA AND INDEPENDENT MEASURES OF GROUNDWATER RECHARGE.
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W91-05430

NEW METHOD FOR DETERMINING CONCENTRATIONS OF ENDOD-S (PHYTOLACCA DODECANDRA) IN WATER DURING MOLLUSCICIDING.
Tulane Univ., New Orleans, LA. Dept. of Environmental Health Sciences.
A. Monkiedje, J. H. Wall, A. J. Englande, and A. C. Anderson.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 25, No. 6, p 777-786, 1990. 3 fig, 1 tab, 13 ref.

Descriptors: *Bioassay, *Field tests, *Molluscicides, *Plant toxins, *Thin layer chromatography, Calibrations, Correlation analysis, Correlation coefficient, Hemolysis, Pesticides, Saponins, Water sampling.

A hemolytic method was developed for the quantitative determination of oleanane saponin (Endod-S) in Phytolacca dodecandra (Phytolaccaceae), a plant with potent molluscicidal properties. A chemical method based on thin layer chromatography (TLC) was used as a control for comparison with a hemolysis test. Standard curves for calibration of both tests of Endod-S gave high correlation coefficients. The hemolysis method gave a correlation coefficient of 0.98 for saponin (Endod-S) levels ranging from 1.6 to 4.2 mg/l. The TLC method gave a correlation coefficient of 0.99 for saponin levels above 1.5 microg. Due to the action of saponins on erythrocytes, the hemolysis method could not be used at levels below 1.6 and above 4.2 mg/l. Similarly, sample sizes limited TLC quantification of these saponins at levels below 1 microg. Both the TLC and the hemolysis methods on identical Endod-S water samples gave comparable results at saponin levels between 2 and 6 mg/L. A snail bioassay showed that the LC50 and the LC90 concentrations of Endod-S to the snail Biomphalaria glabrata (albino) were 2.57 and 2.92 mg/L respectively. These values fell in the standard curve range for the hemolysis method thus indicating that the hemolysis method is of practical value for testing Endod-S concentrations that would actually be used in field applications for snail control. The hemolysis method is less expensive than TLC and can easily be adapted to field conditions. (Author's abstract)
W91-05468

RETARDED LEACHING OF NITRATE IN ACID SOILS FROM THE TROPICS: MEASUREMENT OF THE EFFECTIVE ANION EXCHANGE CAPACITY.
Reading Univ. (England). Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W91-05472

PREDICTION OF OXYGEN TRANSFER RATES FROM SIMPLE MEASUREMENTS OF BUBBLE CHARACTERISTICS.
Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Wasserversorgung, Abwasserbeseitigung und Raumplanung.
For primary bibliographic entry see Field 5D.
W91-05522

REAGENTLESS-CONTINUOUS FLOW METHOD FOR DETERMINATION OF AQUEOUS OZONE WITH THIN FILM SEMICONDUCTOR AND APPLICATION TO AN ADVANCED WATER TREATMENT PLANT.
Osaka Prefectural Univ., Sakai (Japan). Lab. of Environmental Chemistry.
For primary bibliographic entry see Field 5F.
W91-05524

WATER SAMPLE CONTAMINATION BY GLASS FIBER AND CELLULOSE FILTERS.
State Univ. of New York, Syracuse. Coll. of Environmental Science and Forestry.
D. H. Bickelhaupt, and J. H. Porter.
Communications in Soil Science and Plant Analysis CSOSA2, Vol. 21, No. 13-16, p 1477-1501, 1990. 9 tab, 13 ref.

Descriptors: *Cellulose, *Chemical analysis, *Contamination, *Membrane filters, *Sample preparation, *Sample preservation, *Sampling, *Water analysis, *Water sampling, Analytical techniques, Ions, Laboratory methods, Performance evaluation, Water quality.

Paper and glass fiber filters, routinely used to remove particulate matter which interferes with analysis, are potential sources of contamination of environmental solution samples. A study was conducted to determine if simulated precipitation and throughfall samples were altered (positive or negative) during filtering with cellulose or glass fiber filters. The magnitude of chemical alteration by five cellulose and five glass fiber filters was tested during the sample preparation of environmental solutions. Solutions chemically similar to precipitation and throughfall in a northeastern U.S. hardwood forest were prepared. Two volumes (50 and 500 mL) were vacuum-filtered. Concentrations of Ca, Mg, Na, K, NO3, Cl, and SO4 were determined. All filters tested contributed either positive or negative contamination for two or more of the analyzed ions. For some ion-filter-solution combinations, the concentrations in the 50 mL samples were different than the concentrations in the 500 mL samples. In general, cellulose filter papers caused less positive contamination than glass fiber filters. Some negative contamination of Ca and Mg was associated with the use of filter papers, but was generally less than ten percent of the concentration of the unfiltered solutions. The authors recommend that glass fiber filters not be used when using anion-cation balance to determine the correction of data. (Agostine-PTT)
W91-05559

EFFICIENCY OF METHANOL:WATER SOLUTIONS FOR METRIBUZIN EXTRACTION FROM SELECTED SOILS.
Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.
For primary bibliographic entry see Field 5A.
W91-05563

ANALYSIS OF SULFATE IN SEWAGE SLUDGE USING ION CHROMATOGRAPHIC TECHNIQUES.
Technical Univ. of Denmark, Lyngby. Inst. for Bioteknologi.
For primary bibliographic entry see Field 5D.
W91-05571

CROSS-FLOW FILTRATION OF COLLOIDS FROM AQUATIC ENVIRONMENTS.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
For primary bibliographic entry see Field 5A.
W91-05585

MULTILEVEL, IN SITU PORE-WATER SAMPLER FOR USE IN INTERTIDAL SEDIMENTS AND LABORATORY MICROCOSMS.
Plymouth Marine Lab. (England).
P. G. Watson, and T. E. Frickers.
Limnology and Oceanography LIOCAH, Vol. 35, No. 6, p 1381-1389, September 1990. 4 fig, 5 tab, 18 ref. UK Dept. of the Environment PECD 7/7/163.

Descriptors: *Instrumentation, *Intertidal areas, *Laboratory methods, *Samplers, *Sediment analysis, *Sediment sampler, Centrifugation, Interstitial water, Temporal variation.

A sampler for in situ separation of pore fluids from intertidal sediments and in laboratory microcosms offers marked improvements in resolution, number of sampling depths, compactness, and simplicity over previously reported devices. The sampler is operated by applying a vacuum to chambers linked, through porous segments, to successive depths in the sediment profile. Analyses of replicate samples taken at hourly intervals (total alkalinity, pH, dissolved Fe(2-) and Mn(2-) show that concentration changes induced by the sampler with time are small compared to those due to natural sediment variability. Sampling accuracy is assessed from comparative analyses of pore waters obtained with samplers and by centrifuging core sections. Applications include field sampling of intertidal pore waters, deployment inside benthic chambers, laboratory studies of temporal changes in pore-water compositions, and shipboard sampling of cores collected subtidally. (Author's abstract)
W91-05586

TECHNIQUES FOR APPRAISAL OF GROUND-WATER RESOURCES ON ATOLL ISLANDS: CASE STUDIES FROM MICRONESIA.
Geological Survey, Honolulu, HI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-05640

VERY LOW FREQUENCY ELECTROMAGNETIC MAPPING OF A FRESHWATER LENS AT KEY WEST, FLORIDA.
Environmental Resources Management-South, Inc., Miami, FL.
For primary bibliographic entry see Field 2F.
W91-05642

COMPUTER PROGRAM FOR GEOPHYSICAL LOG DATA MANAGEMENT AND PLOTTING (GEOMAN).
Geological Survey, San Juan, PR. Water Resources Div.
I. E. Arroyo, S. Torres-Gonzalez, and R. A. Carrasquillo.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 395-401, 3 fig, 1 tab, 3 ref.

Descriptors: *Borehole geophysics, *Computer programs, *Data processing, *GEOMAN program, *Groundwater management, *Logging (Recording), *Tropical hydrology, Computers, Data interpretation, Geophysics, Lithology, Plotting, Well logs.

GEOMAN, a menu driven program written in Prime Fortran 77 allows the user to edit, manage and plot borehole geophysical log data obtained from a Mount Sopris logging instrument, Series III. The program supports a five-option menu: (1) reading geophysical log data from cassette tape or file, or digitizing the geophysical logs, (2) identifying well and geophysical logs in the cassette tape or file, (3) editing geophysical logs into a file ready for plotting, (4) entering lithologic information for a particular well, and (5) plotting geophysical and lithologic data for a well or group of wells. The plotting program option allows for vertical and horizontal exaggeration. Other features of GEOMAN include the ability to plot several types of geophysical logs (physical, nuclear, and electric). Cumulative (first derivative) and second derivative plots of selected geophysical logs can also be plotted using this program. The use of GEOMAN facilitates and speeds the management and interpretation of geophysical log data through the use of a digital interface which transfers the field data from the data logger to a standard format. (See also W91-05611) (Lantz-PTT)
W91-05651

USE OF ADSORBED AND NON-ADSORBED TRACERS TO STUDY THE TRANSPORT OF AGRICULTURAL CHEMICALS TO SHALLOW GROUNDWATER.
Iowa State Univ., Ames. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W91-05660

UTILIZATION OF INTRACELLULAR GRANULES OF INT-FORMAZAN AND GENE PROBES FOR TRACING MICROORGANISMS IN GROUND WATER.
Puerto Rico Univ., Rio Piedras. Environmental Microbiology Lab.
For primary bibliographic entry see Field 5B.
W91-05661

USE OF A REMOTE OPERATED VEHICLE (ROV) TO EVALUATE MARINE DISCHARGES OF TREATED WASTEWATER.
Metcalf and Eddy, Inc., Wakefield, MA.
R. J. Reimold, W. K. Scott, M. M. Irizarry, R. G. Nigaglioni, and S. J. Cibik.
IN: Tropical Hydrology and Caribbean Water Resources. Proceedings of the International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, San Juan, Puerto Rico, July 22-27, 1990. American Water Resources Association, Bethesda, Maryland. (1990). p 515-524, 4 fig 8 ref.

Descriptors: *Data acquisition, *Ocean dumping, *Puerto Rico, *Remotely operated vehicles, *Tropical hydrology, *Wastewater disposal, *Wastewater outfall, Bottom sampling, Ecological effects, Marine biology, Samplers, Waste disposal, Water quality.

Between 1979 and 1989 the Puerto Rico Aqueduct and Sewer Authority applied to the US EPA for a waiver of secondary treatment requirements under section 301(h) of the Clean Water Act. As part of this process, an ROV (Remote Operated Vehicle), coupled with conventional quantitative benthic grab sampling (using a van Veen sampler), was used to determine the benthic ecological conditions adjacent to marine wastewater discharges from Bayamon/Puerto Nuevo and Ponce, Puerto Rico. The ROV also proved effective in documenting the ecological conditions in marine areas where hard bottom conditions, or quantities of coral rubble, precluded the successful use of the van Veen sampler. Integration of conventional water quality and biological monitoring results with ROV videotapes and still photographs provided a greater ability to assess the impacts associated with 301(h) permitted discharges. In the future, ROVs will be used in a expanded role in various aspects of marine biological investigations. The results of implementation of this approach will provide cost-effective and environmentally-comprehensive data for the evaluation of any marine discharge. (See also W91-05611) (Author's abstract)
W91-05663

APPLICATIONS OF FORWARD MODELING RESISTIVITY PROFILES.
United Nations Educational, Scientific and Cultural Organization, Paris (France). Div. of Water Sciences.
For primary bibliographic entry see Field 2F.
W91-05814

USE OF ATOMIC ABSORPTION SPECTROSCOPY WITH A GRAPHITE FURNACE TO DETERMINE ARSENIC IN NATURAL WATERS AND AQUEOUS SOIL EXTRACTS.
For primary bibliographic entry see Field 5A.
W91-05829

DECAMETRIC VARIABILITY OF SOUDANO-SAHELIAN RAINFALL FIELDS (VARIABILITE SPATIALE DES PRECIPITATIONS SOUDANO-SAHELIENNES A L'ECHELLE DECAMETRIQUE).
Laboratoire de Geologie Appliquee, Paris (France).
For primary bibliographic entry see Field 2B.
W91-05850

RETRIEVAL OF PRECIPITATION PROFILES FROM AIRBORNE RADAR AND PASSIVE RADIOMETER MEASUREMENTS: COMPARISON WITH DUAL-FREQUENCY RADAR MEASUREMENTS.
Wisconsin Univ., Madison. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W91-05852

SNOW/CLOUD DISCRIMINATION WITH MULTISPECTRAL SATELLITE MEASUREMENTS.
Naval Postgraduate School, Monterey, CA. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W91-05853

RETRIEVAL OF WATER VAPOR PROFILES FROM MICROWAVE RADIOMETRIC MEASUREMENTS NEAR 90 AND 183 GHZ.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W91-05854

ESTIMATION OF AREA-AVERAGED RAINFALL OVER TROPICAL OCEANS FROM MICROWAVE RADIOMETRY: A SINGLE CHANNEL APPROACH.
Texas A and M Univ., College Station. Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W91-05855

EVALUATION OF CONSTRUCTED AND NATURAL SOIL MACROPORES USING X-RAY COMPUTED TOMOGRAPHY.
Missouri Univ.-Columbia. Dept. of Agronomy.
For primary bibliographic entry see Field 8D.
W91-05874

SEPARATION AND SIMULTANEOUS DETERMINATION OF ALUMINUM, IRON, AND MANGANESE IN NATURAL WATER SAMPLES BY USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY WITH SPECTROPHOTOMETRIC AND ELECTROCHEMICAL DETECTION.
Fukui Univ. (Japan). Faculty of Engineering.
Y. Nagaosa, and H. Kawabe.
Analytical Chemistry ANCHAM, Vol. 63, No. 1, p 28-33, January 1, 1991, 5 fig, 4 tab, 41 ref.

Descriptors: *Aluminum, *Analytical methods, *Electrochemistry, *High performance liquid chromatography, *Iron, *Liquid chromatography, *Manganese, *Separation techniques, *Spectrophotometry, *Water analysis, Detection limits, Electrodes, Heavy metals, Measuring instruments, Trace levels.

Reversed-phase liquid chromatography has been used to determine simultaneously trace levels of Al, Fe, and Mn in natural water samples after direct injection of their 9-quinolinol complexes onto a Bondasphere ODS column. Chromatographic separation can be made with the mobile phase of 2:3 acetonitrile/20 mM acetate buffer solution containing 5 mM of 8-quinolinol reagent. Excellent sensitivity is obtained by spectrophotometric de-

tection at 390 nm. The spectrometric detection limits of these metals are at the part per billion levels of test solution. The tolerance limits of numerous other metal ions are reported. Only Cr(III) and Ni(II) interfere with determination of Al, and Mo(VI) interferes with the determination of Mn at concentrations less than a 100-fold excess. Analytical data obtained on river and sea water samples are in agreement with expected values. Amperometric detection of Mn and Fe with thin-layer flow cell and glassy-carbon working electrode proved less sensitive but more specific than spectrophotometric detection. (Author's abstract)
W91-05892

REAL SAMPLE ANALYSIS BY ETA-LEAFS WITH BACKGROUND CORRECTION: APPLICATION TO GOLD DETERMINATION IN RIVER WATER.
CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses (France). Dept. de Chimie Appliquee et d'Etudes Analytiques.
B. Remy, I. Verhaeghe, and P. Mauchien.
Applied Spectroscopy APAPA4, Vol. 44, No. 10, p 1633-1638, December 1990, 12 fig, 1 tab, 25 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Fluorescence spectroscopy, *Gold, *Lasers, *Water analysis, Fluorescence, Heavy metals, Measuring instruments, Spectroscopy, Stream chemistry, Trace elements.

Very low limits of detection have been achieved by ETA-LEAFS (electrothermal atomizer/laser-excited atomic fluorescence spectrometry), but the full analytical potential of this technique has yet to be reached. Laser-induced fluorescence has been demonstrated to be a very powerful technique for ultratrace analysis in liquid samples. Single-step excited direct line fluorescence performed in a commercial graphite-furnace tube atomizer was used for cobalt and gold analysis in pure water. The problem of matrix interferences with this apparatus was evaluated using gold determination in river water. A specifically-designed dual monochromator setup was used to correct background fluorescence resulting from a high concentration of molecular species in the matrix. Detection limits obtained in pure water were 4 fg for cobalt and 10 fg for gold, and the background correction efficiency is demonstrated by the analysis of gold in river water at 300 fg level with 15% precision. (Doyle-PTT)
W91-05893

APPLICATION OF INAA AND PIXE ON THE ANALYSIS OF NUTRITIONAL AND TOXICOLOGICAL ELEMENTS IN SAMPLES OF DRINKABLE WATER.
Florence Univ. (Italy). Dipt. di Fisica.
For primary bibliographic entry see Field 5F.
W91-05899

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF STANDARD REFERENCE MATERIAL 1941, ORGANICS IN MARINE SEDIMENT.
National Inst. of Standards and Technology (NML), Gaithersburg, MD. Center for Analytical Chemistry.
For primary bibliographic entry see Field 5A.
W91-05900

7C. Evaluation, Processing and Publication

GLOBAL WORLD PROPAGATION OF DRYNESS AND WETNESS WAVES (PROPAGATION DES ONDES DE SECHERESSE ET D'HUMIDITE A TRAVERS LE MONDE).
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
For primary bibliographic entry see Field 2B.
W91-04938

SIMULATION OF HYDROCHEMISTRY IN A HIGHLAND SCOTTISH CATCHMENT USING THE BIRKENES MODEL.
Oslo Univ. (Norway). Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W91-04978

REGIONAL SCALE MODEL FOR THE CALCULATION OF EPISODIC CONCENTRATIONS AND DEPOSITIONS OF ACIDIFYING COMPONENTS.
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 5B.
W91-04984

MODELING OF WATER QUALITY IN LAKE TUUSULANJARVI.
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 5G.
W91-05063

GROUNDWATER MODELS OF THE MIOCENE AQUIFER SYSTEM IN JONES COUNTY, MISSISSIPPI.
Delta Environmental Consultants, Inc., Tampa, FL.
For primary bibliographic entry see Field 2F.
W91-05154

NEW STATE GEOLOGIC MAP FOR MISSISSIPPI: A TOOL FOR UPDATING NOMENCLATURE AND DEFINITIONS OF THE STATE'S AQUIFERS AND AQUITARDS.
D. T. Dockery.
In: Proceedings, Twentieth Mississippi Water Resources Conference, April 10-11, 1990. Jackson, Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi 39762. 1990. p 175-177, 11 ref.

Descriptors: *Aquifer management, *Geologic mapping, *Mississippi, *Water resources management, Aquitards, Computerized maps, Decision making, Environmental policy, Geohydrologic units, Geologic formations, Stratigraphy.

The Mississippi Bureau of Geology has increased its staff of geologic mappers and is undertaking work toward the production of a new state geologic map. Problem areas of the 1969 map are being remapped on 7 minute quadrangles. These quadrangle maps can be digitized and made available to the public. A new state geologic map along with quadrangle maps and the continuing county bulletin series will provide the detailed surface geologic data needed for groundwater and environmental management decisions as well as to document the state's surficial mineral resources. These maps may also serve as legal documents for defining formations and their boundaries and for providing the correct stratigraphic nomenclature for aquifers and aquitards. (See also W91-05137) (Fish-PTT)
W91-05158

SIMULATION OF WATER FLOW FROM A PERCOLATION TEST HOLE IN LAYERED SOIL.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W91-05175

EVALUATION OF OPTIMUM THICKNESS OF BOTTOM INSULATION FOR A CONVENTIONAL SOLAR STILL.
Indian Inst. of Tech., New Delhi. Centre of Energy Studies.
For primary bibliographic entry see Field 3A.
W91-05197

EVALUATION OF A SMALL UNSTEADY CONTINUOUS FLOW RBC SYSTEM.
Jordan Univ. of Science and Technology, Irbid. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05206

SIMULATION MODELING OF PRIMARY CLARIFIERS (CASE STUDY OF DOHA TREATMENT PLANT).
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Coll. of Engineering.
For primary bibliographic entry see Field 5D.
W91-05207

NUMERICAL MODELING OF HYDRODYNAMICS. BRAZOS ISLAND HARBOR PROJECT, TEXAS (BROWNSVILLE SHIP CHANNEL).
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2E.
W91-05268

UPDATING THE SMITH-FEDDES MODEL.
Arvin/Calspan Advanced Technology Center, Buffalo, NY.
For primary bibliographic entry see Field 2B.
W91-05277

GEOGRAPHIC INFORMATION SYSTEM DOCUMENTATION OF WATERSHED DATA FOR DIRECT/DELAYED RESPONSE PROJECT: SOUTHERN BLUE RIDGE PROVINCE DATABASE.
NSI Technology Services Corp., Corvallis, OR.
D. Mortenson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-219539. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/3-89/002, March 1989. 26p, 2 fig, 1 tab, 8 ref, 6 append.

Descriptors: *Water pollution sources, *Geographic Information Systems, *Databases, *Computers, *Acid rain effects, *Path of pollutants, Data storage and retrieval, Blue Ridge Mountains, Mapping.

The Direct/Delayed Response Project (DDRP) was designed by the US EPA within the National Acid Precipitation Assessment Program (NAPAP) to predict the long-term response of watersheds and surface waters to acidic deposition. The purpose of the DDRP is to investigate and distinguish the time scales over which surface water systems might change chemically under varying levels of acidic deposition. The DDRP is examining of subset of watersheds sampled in the US EPA National Surface Water Survey. In the Southern Blue Ridge Province Region of the United States, 35 watersheds are under study. The DDRP required detailed watershed information on those characteristics thought important relative to the effects of acid deposition. This information was then mapped, then entered into a Geographic Information System (GIS). Protocols, guidelines, and standards were used to complete GIS entry of the mapping data, and quality control procedures were used to ensure accuracy and consistency. (Author's abstract)
W91-05278

FATE AND TRANSPORT OF COMBINED RESIDUAL CHLORINE IN SMALL STREAM.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-05325

HEURISTIC DESIGN OF SEWER NETWORKS.
Kuwait Univ., Safat. Dept. of Electrical and Computer Engineering.
For primary bibliographic entry see Field 5D.
W91-05328

IMPACT ASSESSMENT FOR THE FRENCH NUCLEAR WEAPON TEST SITES IN FRENCH POLYNESIA.
Sydney Univ. (Australia). Ocean Sciences Inst.

For primary bibliographic entry see Field 5B.
W91-05347

SIMULATION OF GROUNDWATER FLOW IN COMPLEX MULTIAQUIFER SYSTEMS: PERFORMANCE OF A QUASI THREE-DIMENSIONAL TECHNIQUE IN THE STEADY-STATE CASE.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2F.
W91-05360

DEVELOPMENT OF AN AUTOMATED SPATIAL SYNOPTIC CLIMATOLOGICAL CLASSIFICATION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2B.
W91-05373

BIAS AND VARIANCE OF QUANTILE ESTIMATES FROM A PARTIAL DURATION SERIES.
Royal Netherlands Meteorological Inst., De Bilt.
T. A. Buishand.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 35-49, December 1990. 6 fig, 9 ref, 3 append.

Descriptors: *Data interpretation, *Mathematical models, *Partial duration series, *Poisson ratio, *Statistical analysis, *Statistical methods, *Statistics, Mathematical studies, Rainfall, Statistical models.

Partial duration series methods have been used to estimate the T-year event Zt of a hydrological variable. The maximum likelihood estimate of Zt is considered for the model with a Poisson number of peaks and, independently, exponentially distributed peak magnitudes. The mean and the variance of maximum likelihood of Zt are evaluated by finite summations. Approximations to the bias the maximum likelihood of Zt are expressed by a simple analytical expression. Even when the expected number of peaks is small, the asymptotic expression for the variance of the estimated T-year event gives acceptable results. The poorest results with this expression are obtained when the quantile of interest is close to the base level. The corrections for non-asymptotic behavior differ from those proposed previously by other researchers. The variance of the quantile estimate strongly depends on the underlying partial duration series model. The effect of a slight departure from the assumed exponential distribution is generally much larger than the error from the use of a simple asymptotic expression. (Geiger-PTT)
W91-05429

PARAMETER ESTIMATION FOR SEASONAL TO SUBSEASONAL DISAGGREGATION.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
G.-F. Lin.
Journal of Hydrology JHYDA7, Vol. 120, No. 1-4, p 65-77, December 1990. 3 fig, 11 ref. National Science Council, Republic of China Grant NSC 79-0410-E002-13.

Descriptors: *Mathematical models, *Model studies, *Seasonal variation, *Streamflow, Data interpretation, Error analysis, Hydrologic models, Mathematical studies, Simulation analysis.

A model structure of staged disaggregation using the full Mejia and Rousselle model is considered and the parameter estimation problem for this model is addressed. A technique is developed to derive the corrected parameter estimation equations associated with the use of the Mejia and Rousselle model for a two-stage disaggregation scheme. The technique is based on making the parameter estimation equations mathematically consistent. Following this technique, it was found that corrected parameter estimation equations for the Mejia and Rousselle model were conditional on its key series (input) generation model. With parameters estimated from corrected parameter estimation equations coupled with the corrected moment estimates for the preservation of additivity, the modeling, in theory, can exactly preserve the important moments of interest and the additivity. The effects of using the corrected parameter estimation scheme are also verified by an example which generates monthly flows by disaggregating quarterly flows which were in turn disaggregated from annual flows from historical data of Shihmen station in the Tanshui River Basin, Taiwan. The models, using the corrected parameter estimates, performed better than that using the original parameter estimates in the reproduction of the historical moments. (Author's abstract)
W91-05431

ESTIMATION OF THE GEV DISTRIBUTION FROM CENSORED SAMPLES BY METHOD OF PARTIAL PROBABILITY WEIGHTED MOMENTS.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 2E.
W91-05433

UNBIASED ESTIMATION OF PROBABILITY WEIGHTED MOMENTS AND PARTIAL PROBABILITY WEIGHTED MOMENTS FROM SYSTEMATIC AND HISTORICAL FLOOD INFORMATION AND THEIR APPLICATION TO ESTIMATING THE GEV DISTRIBUTION.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 2E.
W91-05434

MODELLING STREAM ACIDIFICATION IN AFFORESTED CATCHMENTS: LONG-TERM RECONSTRUCTIONS AT TWO SITES IN CENTRAL SCOTLAND.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5C.
W91-05436

CRITICAL DROUGHT ANALYSIS BY SECOND-ORDER MARKOV CHAIN.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W91-05438

COMPARISON OF ESTIMATES OF SNOW INPUT WITH A SMALL ALPINE CATCHMENT.
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 2C.
W91-05444

USE OF COLOR SPLITTING AND A COMPUTER TECHNIQUE TO SEPARATE SOIL MOISTURE GROUPS.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2G.
W91-05605

SOIL, LANDSCAPE, AND EROSION RELATIONSHIPS IN A NORTHWEST ILLINOIS WATERSHED.
Illinois Univ., Urbana. Dept. of Agronomy.
For primary bibliographic entry see Field 2J.
W91-05606

REGIONAL EQUATIONS TO DETERMINE PEAK STREAM DISCHARGES IN THE SANTANDER REGION, COLOMBIA.
Universidad Industrial de Santander, Bucaramanga (Colombia). Dept. de Ingenierria Civil.
For primary bibliographic entry see Field 2E.
W91-05636

GEOPHYSICAL MAPPING AND HYDROGEOLOGIC ANALYSIS OF FRESH-WATER LENSES AT BIG PINE KEY, FLORIDA.
University of South Florida, Tampa. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W91-05641

VERY LOW FREQUENCY ELECTROMAGNETIC MAPPING OF A FRESHWATER LENS AT KEY WEST, FLORIDA.
Environmental Resources Management-South, Inc., Miami, FL.
For primary bibliographic entry see Field 2F.
W91-05642

APPLICATION OF THE BOUNDARY ELEMENT METHOD TO SOME PROBLEMS IN WATER RESOURCES.
Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2F.
W91-05645

COMPUTER PROGRAM FOR GEOPHYSICAL LOG DATA MANAGEMENT AND PLOTTING (GEOMAN).
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 7B.
W91-05651

INTERACTIVE COMPUTER PROGRAM MODUMANAG, A DATA MANAGEMENT TOOL FOR THE MODULAR FINITE-DIFFERENCE GROUND-WATER FLOW MODEL.
Geological Survey, San Juan, PR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W91-05652

MODELLING POINT-OF-ENTRY RADON REMOVAL BY GAC.
Maine Univ., Orono.
For primary bibliographic entry see Field 5F.
W91-05713

TESTING STOCHASTIC DYNAMIC PROGRAMMING MODELS CONDITIONED ON OBSERVED OR FORECASTED INFLOWS.
Bureau of Environmental Protection, Taipei (Taiwan).
For primary bibliographic entry see Field 2E.
W91-05788

CLIMATIC SENSITIVITY OF CALIFORNIA WATER RESOURCES.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W91-05793

CLIMATE CHANGE, HYDROLOGY, AND WATER RESOURCES.
Pacific Inst. for Studies in Development, Environment and Security, Berkeley, CA.
For primary bibliographic entry see Field 2A.
W91-05799

EMPIRICAL BAYES REGIONALIZATION METHODS FOR SPATIAL STOCHASTIC PROCESSES.
Gradient Corp., Cambridge, MA.
For primary bibliographic entry see Field 2F.
W91-05832

CONVEX INTERPOLATION FOR GRADIENT DYNAMIC PROGRAMMING.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
E. Foufoula-Georgiou.
Water Resources Research WRERAQ, Vol. 27,

No. 1, p 31-36, January 1991. 4 fig, 17 ref. NSF Grant BSC-8957469.

Descriptors: *Dynamic programming, *Hermite interpolation, *Mathematical models, *Model studies, Computer models, Discrete dynamic programming, Errors, Interpolation, Optimization, Performance evaluation, Theory.

Local approximation of functions based on values and derivatives at the nodes of a discretized grid are often used in solving problems numerically for which analytical solutions do not exist. In gradient dynamic programming, the use of such functions for the approximation of cost-to-go function alleviates the 'curse of dimensionality' by reducing the number of discretization nodes per state while obtaining high-accuracy solutions. Also, sufficient Newton-type schemes can be used for the stage-wise optimization, because now the approximation functions have continuous first derivatives. Of particular interest is the case where the cost-to-go function is convex. Interpolants, however, may not always be convex, introducing numerical problems. The problem of interpolating nodal values and derivatives of a one-dimensional convex function with a convex interpolant is addressed in such a way that potential computational difficulties due to approximation-induced nonconvexity are avoided and an efficient convergence to global rather than local optimal controls is guaranteed at every single-stage optimization. Hermite interpolating polynomials have found extensive application in finite element methods for the numerical solution of partial differential equations arising in many engineering and scientific problems. The advantage of using Hermite interpolation both in the context of discrete optimization and in the context of numerically solving partial differential equations will be realized fully when these polynomials result in a convex interpolation of convex functions. The conditions of convexity in multidimensional Hermite interpolation are fairly complicated, as is the study of the feasibility and construction of multidimensional convex interpolants. From the practical standpoint, the usefulness of these methods is expected to be much greater in problems of large dimensionality. (Rochester-PTT)
W91-05834

NONPARAMETRIC VARIABLE KERNEL ESTIMATION WITH HISTORICAL FLOODS AND PALEOFLOOD INFORMATION.
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
For primary bibliographic entry see Field 2E.
W91-05839

CLIMATOLOGICALLY TUNED REFLECTIVITY-RAIN RELATIONS AND LINKS TO AREA-TIME INTEGRALS.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W91-05858

FRACTALS, RAINDROPS AND RESOLUTION DEPENDENCE OF RAIN MEASUREMENTS.
McGill Univ., Montreal (Quebec). Dept. of Physics.
For primary bibliographic entry see Field 2B.
W91-05860

USING MORPHOMETRIC EXPRESSIONS FOR MACROPORES TO IMPROVE SOIL PHYSICAL ANALYSES OF FIELD SOILS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 2G.
W91-05873

NONLINEAR CHANCE CONSTRAINED MODEL FOR IRRIGATION PLANNING.
Asian Inst. of Tech., Bangkok (Thailand).
For primary bibliographic entry see Field 3F.
W91-05922

TRANSIENT HYDRAULIC MODELING FOR IMPROVED CANAL SYSTEM OPERATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
For primary bibliographic entry see Field 3F.
W91-05929

NEW TOOL: DELINEATION OF TEXTURAL HETEROGENEITIES IN UNCONFINED AQUIFERS, USING MICROGRAVITY SURVEYS DURING PUMPING.
Colorado School of Mines, Golden. Dept. of Geology and Geological Engineering.
For primary bibliographic entry see Field 2F.
W91-05937

DYNAMIC MODELING OF WASTEWATER TREATMENT PROCESSES.
Laval Univ., Quebec. Dept. of Civil Engineering.
P. Lessard, and M. B. Beck.
Environmental Science and Technology ESTHAG, Vol. 25, No. 1, p 30-39, January 1991. 2 fig, 139 ref.

Descriptors: *Dynamic programming, *Model studies, *Wastewater treatment, *Water pollution control, Biological treatment, Clarifiers, Linguistic models, Lumped-parameter models, Sedimentation, Sludge treatment, Storm wastewater, Storm water management, Time-series models.

Until recently, the main task for river pollution control in populous industrialized regions has been to mitigate the effects of gross pollution, usually as measured in terms of biochemical oxygen demand, and suspended solids. What has become of increasing concern is not only the mean fixed level of water quality to be achieved in the future, but also the operational problem of maintaining, or improving, this baseline condition in the face of a more readily apparent temporal variability of types and levels of pollution. Effective control of the dynamic behavior of a unit process, or of the entire treatment plant, depends on three factors: the ability to observe the state of the process and its response to various perturbations (monitoring); the ability to relate unambiguously causes to effects; and the capacity to act, that is, to manipulate the causes to correct undesirable effects or to bring about more desirable effects. In order to relate causes to effects a dynamic, unsteady-state model is the most natural form of representation. The current status of modeling wastewater treatment units has been summarized and those models that would be of most use in studying and advancing the operation of these units in the wider context of river quality management are identified. Four types of models can be distinguished for the description of the dynamic process: linguistic models; time-series or black-box models; lumped-parameter models; and distributed-parameter models. Model applications are considered for: (1) storm sewage retention; (2) primary sedimentation; (3) secondary treatment processes such as suspended growth, biological reactors, secondary clarifiers, and attached-growth; (4) sludge treatment; (5) the plant as a whole; and (6) likely paths of innovation. (White-Reimer-PTT)
W91-05948

USE OF COLLOID FILTRATION THEORY IN MODELING MOVEMENT OF BACTERIA THROUGH A CONTAMINATED SANDY AQUIFER.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W91-05958

8. ENGINEERING WORKS

8A. Structures

ANCHORING A DAM.
R. A. Bragg, P. M. Wimberly, and T. J. Flaherty.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 12, p 38-41, December 1990.

Descriptors: *Anchors, *Dam stability, *West Virginia, Concrete dams, Dam construction, Drainage, History, Lake Lynn.

Lake Lynn Dam, a concrete gravity dam situated 3.6 miles upstream from where the Cheat River meets the Monongahela River, in West Virginia, was constructed over the period 1912-1926. The generating capacity at this dam is 50,000 kw. In response to a safety inspection conducted in the period 1982-1989, remedial measures were undertaken that almost doubled the dam's previous design flood capacity. Previously, in 1972, the 16 post-tensioned anchors with design loads of 705 kips each were installed in the east bulkhead. Although this strengthened the bulkhead's overturning stability for floods up to about 50% of the probable maximum flood, more stringent regulations necessitated further work. Operating from platforms nearly 100 ft above the waters of the Cheat River, workmen installed 75 rock anchors, including the largest ever assembled in North America. The work was part of a $4 million program of stability improvement. Also included in this program were improvements to a drainage system of 46 drains to maintain uplift pressure on the base of the dam at close to the hydrostatic tailwater pressure. Original construction drawings were unclear concerning the locations of originally installed drains, so the first step in this project was to clean and map the existing drain system. There are now 84 functioning drains and PVC-lined foundation drain holes at Lake Lynn Dam. The design flood used in the analysis was 477,000 cfs, about 1.7 times the design flood used in the 1972 stability evaluation. (Rochester-PTT)
W91-05069

CALCULATED PREDICTION OF EARTH PRESSURES ON TAILWATER TUNNELS OF THE ROGUN HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8E.
W91-05076

WATER-HOLDING CAPACITY OF STRUCTURES MADE OF SAND-GRAVEL-PEBBLE SOILS.
For primary bibliographic entry see Field 8D.
W91-05078

LOW-CLINKER CEMENT FOR HYDRAULIC STRUCTURES.
For primary bibliographic entry see Field 8F.
W91-05079

USE OF PRECAST REINFORCED-CONCRETE BEAMS IN THE FLOORS OF THE DRAFT TUBES OF THE CHEBOKSARY HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8F.
W91-05081

CONCEPT OF SAFETY EVALUATION OF THE ARCH DAM OF THE INGURI HYDROELECTRIC STATION.
G. Y. Berdichevskii, V. I. Bronshtein, and Y. B. Mgalobelov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 26-30, 1990. 2 fig, 1 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 24-27, January, 1990.

Descriptors: *Arch dams, *Dam design, *Dam stability, Dam inspection, Hydroelectric plants, Materials engineering, Measuring instruments, Seepage, Soviet Union, Structural engineering.

Problems of the reliability and safe operation of the arch dam at the Inguri hydroelectric station (Soviet Union), a record dam in height and unique in many parameters and construction conditions, were decisive at all stages of its design, construction, and temporary operation. An extensive combination of surveying, research, design, and experimental field work without precedent in Soviet dam construction was performed to substantiate the reliability. Numerous on-site observations are pro-

vided during operation for checking the safety of the arch dam; about 3000 embedded instruments were placed in the structure and foundation. The evaluation of the technical state and safety of the Inguri dam is based on the following principles: (1) the actual state of the dam-foundation system determined by on-site observations should correspond to the design concepts about behavior of this system and (2) the indices of state measured in the prototype should form a system having sufficient completeness ensuring the necessary reliability of conclusions about the correspondence of prototype and design. The following indices of the state of the arch dam served for checking the correspondence between the actual behavior of the dam and the design concepts: (1) stresses at the points of installing rosettes of linear strain-gauge transducers; (2) displacements of the dam and rock foundation relative to the base points, which are considered fixed; and (3) indices characterizing seepage in the rock foundation of the dam as well as seepage discharges at the gaging stations and piezometric levels monitoring the piezometric heads in the rock contact zone and the behavior of grout curtain and drainage. Deformation and strength characteristics of the rock foundation, elastic wave velocities and cyclic load during operation of the dam, and stresses in the antiseismic reinforcement also are monitored. (Rochester-PTT)
W91-05082

OPTIMIZATION OF THE DESIGNS OF EARTH DAMS.
L. N. Rasskazov, and V. Sepeda.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 30-35, 1990. 4 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 27-30, January, 1990.

Descriptors: *Construction costs, *Dam design, *Earth dams, *Economic aspects, Cost analysis, Design criteria, Hydraulic engineering, Hydraulic structures, Optimization, Pareto method.

Optimization of the designs of hydraulic structures in general and of earth dams in particular becomes an inseparable part of design, because it makes possible the selection of the most economical design while fulfilling all technical specifications. Calculation procedures were investigated for various methods of optimization and their relative performance was evaluated, particularly with regard to the economic effect of using each method of optimization. Of the methods of optimization investigated (Pareto, penalty functions, and direct search), the most convenient is the direct search method, because it makes it possible to adhere to all constraints. However, the other methods also have benefits. For example, the Pareto method makes possible a complex, although approximate, evaluation of the performance of the structure. Optimization enables the reduction of the cost of the designs of earth dams by 5-15%. (Rochester-PTT)
W91-05083

HYDROSTATION RESERVOIRS AND RECREATION.
S. B. Elakhovskii.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 44-48, 1990. 1 fig, 10 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 36-39, January, 1990.

Descriptors: *Multipurpose reservoirs, *Planning, *Recreation, *Recreation facilities, *Reservoirs, *Soviet Union, Economic aspects, Hydroelectric plants, Management planning, Systems engineering, Water resources development.

In the Soviet Union, particularly the 500-700 km wide strip along the entire southern boundary of the country, the demand for recreational opportunities in lakes and rivers is increasing rapidly. Various countries, such as the United States and Czechoslovakia, have progressed quite far in the development of reservoirs for recreational use. To develop recreation in the Soviet Union will require an intensified effort. Two ways to solve the problem of providing more recreational facilities at reservoirs are: (1) to thoroughly study the problem, including considering new economic structures and the use of specialized technical teams of specialists and (2) to create or improve recreational and sports facilities at reservoirs already in recreational use. The Sayano-Shushenskoe hydro station reservoir is a unique case in which the creation of a reservoir actually improved access to a beautiful natural setting and created a large (621 sq km) lake with 1400 km of shoreline. Two thrusts for future development of this site to improve recreation have been identified: (1) improved walking routes and provision for horseback riding and winter sports and (2) creating large establishments on the shore with places for overnight stays, boat hire, fishing and hunting, and bases for collection of pine nuts. It is the duty of hydropower engineers to compensate for the country's population with recreational benefits for those negative impacts associated with some earlier hydro projects. The recreational use of a given reservoir increases its effectiveness as a multipurpose hydro development (and thereby increases the competitiveness of the hydro station as a power facility). (Rochester-PTT)
W91-05086

RELIABILITY OF THE ASSURANCE OF STABILITY OF EARTH MASSES.
For primary bibliographic entry see Field 8D.
W91-05088

CONCRETE-FACED ROCKFILL DAM.
Cooke (J. Barry), Inc., San Rafael, CA.
J. B. Cooke.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 11-15, January 1991. 3 fig.

Descriptors: *Concretes, *Dam construction, *Facings, *Rockfill dams, Compaction, Dam stability, Design criteria, History, Modulus of compressibility, Performance evaluation, Shear strength.

The concrete-faced rockfill dam (CFRD) is now well established as a dam type to be considered in feasibility studies. The leakage experience with early high CFRDs of dumped rockfill limited the acceptance of this dam in the 1950s, and the development of the earth core rockfill dam began. After the advent of compacted rockfill in the 1960s, many CFRD dams, including high ones, were constructed, and their performance and economy have restored the CFRD as a major dam type. Compacted rockfill has properties that are particularly useful: high shear strength and high modulus of compressibility. The traffic of loaded trucks and the movements of the spreading dozer provide effective compaction, which is supplemented by passes of the smooth drum vibratory roller. For sound (hard) rock, the fines and small rocks in the upper zone of a layer are well compacted. Since all rockfill of sound rock is highly segregated in each layer, grading of quarry-run rock is not important. The use of water improves rockfill properties, particularly reducing compressibility. For sound (hard) rock, the specifications can be general and precise. Compacted rockfill and the modern features of CFRD design combine to provide an inherently safe and economical dam. The CFRD can be considered for the highest dams and for major projects. (Rochester-PTT)
W91-05116

DESIGN AND CONSTRUCTION OF THE SEGREDO CONCRETE-FACED ROCKFILL DAM.
Companhia Paranaense de Engeria, Curitiba (Brazil).
S. H. Neidert, and N. B. Toniatii.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 15-19, January 1991. 5 fig, 3 ref.

Descriptors: *Brazil, *Concretes, *Dam construction, *Hydroelectric plants, *Rockfill dams, Civil engineering, Compaction, Hydraulic structures, Iguacu River, Segredo Project, Spillways.

The Segredo project, presently under construction, is the second hydroelectric plant comprising a concrete-faced rockfill dam (CFRD) to be built by Companhia Paranaense de Energia (COPEL) in southern Brazil. The plant is sited downstream of the Foz do Areia dam, on the Iguacu River, in Parana State. Construction was initiated in November 1986 and the first turbine is scheduled to go on line in October 1992. The first phase generating capacity at Segredo will 1260 MW. The choice of a CFRD resulted mainly from economic considerations corroborated by COPEL's positive experience in constructing and operating the Foz do Areia dam. The rockfill was obtained mostly from the excavation required for the hydraulic structure. The rockfill embankment and the concrete membrane will both be built in two stages. The upstream slope will be 1 V:1.3 H and the downstream nominal slope was maintained at 1:1.4, but the actual slopes between access road berms are 1:1.2. Compaction of the upstream third of the rockfill embankment, including the transition zone, is by 6 passes of a 9-t roller, with 25% added water. The plinth slab was cast as a continuous slab, dowelled to the rock, without joints, except for construction joints with reinforcement passing through. As of July 1990, the first stage of rockfill placement was complete; excavation was 80% complete; and the total volume of concrete placed had reached 20% of the total. The finished dam will be 145 m high and will bring the installed capacity on the main river to 6000 MW. The major civil engineering feature of the project will be the 15,000 cu m/sec spillway, with a 400-m chute, unlined along its 280-m downstream portion. (Rochester-PTT)
W91-05117

ADVANCES IN FACE SLAB CONSTRUCTION TECHNIQUES FOR CFRDS.
Tasmania Hydro-Electric Commission, Hobart (Australia). Engineering Div.
For primary bibliographic entry see Field 8F.
W91-05118

COLOMBIAN EXPERIENCE WITH CONCRETE FACE ROCKFILL DAMS.
Ingetec S.A., Bogota (Colombia).
A. Marulanda, F. Amaya, and C. A. Ramirez.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 25-32, January 1991. 13 fig, 3 tab, 12 ref.

Descriptors: *Colombia, *Concretes, *Dam construction, *Design criteria, *Rockfill dams, Alto Anchicaya Dam, Geology, Golillas Dam, Salavajina Dam.

Three major concrete-face rockfill dams (CFRDs) have been constructed in Columbia between 1965 and 1985: Alto Anchicaya (140 m), Golillas (125 m), and Salavajina (148 m). The three dams have, respectively, 22,300 sq m, 14,300 sq m, and 57,459 sq m of face area. The design thickness of the face slab was established as a minimum of 0.3 m at the top and increased with hydrostatic head (H), as follows: 0.003 H at Alto Anchicaya, 0.0037 H at Golillas, and 0.0031 H at Salavajina. At all three dams, the 28 day design compressive strength of the concrete was 210 kg/sq cm. The width of the slabs (joint spacing) was 15 m, and slide forms were used. The concrete facing at Alto Anchicaya was built in two stages, leaving a horizontal construction joint at the elevation of the termination point of the impervious material covering the concrete slab. At the other two sites, three stages were used, leaving two horizontal construction joints. Important lessons learned include: (1) the influence of the shape of the canyon on the deformation of compacted fills; (2) the possibility of building CFRDs in geological conditions previously considered unfavorable for this type of dam; (3) the development of more convenient features to ensure adequate performance of the waterstop in the joints of the concrete slabs; (4) the optimization of both the concrete thickness and the reinforcement of the impervious element; and (5) knowledge about leakage problems that can occur during the first filling and of remedial measures that can be adopted without greatly affecting the operation of the project. (Rochester-PTT)
W91-05119

PROPERTIES AND USE OF FLY ASHES FOR EMBANKMENTS.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W91-05122

METHOD OF TRANSIENT ANALYSIS OF THREE-DIMENSIONAL DAM-RESERVOIR INTERACTIONS.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W91-05124

LA VILLITA DAM RESPONSE DURING FIVE EARTHQUAKES INCLUDING PERMANENT DEFORMATION.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8E.
W91-05125

PERFORMANCE DATA FOR A SLOPED REINFORCED SOIL WALL.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W91-05365

STUDY AND RECOMMENDATIONS ON THE SAN GERMAN VAULTED BRICK STORM SEWER SYSTEM.
Puerto Rico Univ., Mayaguez. Dept. of General Engineering.
For primary bibliographic entry see Field 5D.
W91-05634

OPTIMAL DESIGN FOR STORM SEWER SYSTEM WITH PUMPING STATIONS.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W91-05787

RESERVOIR PLANNING FOR IRRIGATION DISTRICT.
Iran Univ. of Science and Technology, Tehran. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W91-05791

PARAMETER ESTIMATION FOR WATER DISTRIBUTION NETWORKS.
Arizona Univ., Tucson. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W91-05794

SEISMIC RISK ANALYSIS FOR EARTH DAMS.
Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
M. K. Yegian, E. A. Marciano, and V. G. Ghahraman.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 1, p 18-34, January 1991. 5 fig, 7 tab, 38 ref. National Science Foundation Grant No. DFR-84-12124.

Descriptors: *Dam stability, *Earth dams, *Hydraulic engineering, *Hydraulic structures, *Risk assessment, *Seismic surveys, Dam design, Dam failure, Earthquakes, Embankments, Performance evaluation, Probabilistic process, Safety, Seismic exploration, Seismology.

There are many sources of uncertainty involved in seismic safety evaluations of an embankment or an earth dam. Even when conservative assumptions and selections of parameters are made, there will always be a probability that performance of the dam during its lifetime may not be as predicted. To evaluate the seismic risk of damage or failure of earth dams, a seismic risk analysis procedure has been developed. The future occurrence of earthquakes was probabilistically described in terms of both intensity and number of cycles of ground motion (seismic hazard analysis). Furthermore, a probabilistic procedure for the calculation of permanent deformation of earth dams (seismic performance analysis) was developed, characterizing the seismic event in terms of acceleration, number of cycles, and predominant period of motion. The results of seismic hazard and seismic performance analyses were combined to yield the risk of seismic damage or failure of a dam (seismic risk analysis). An example case study was examined to illustrate the application of the procedures. A risk-based seismic safety evaluation of an embankment or an earth dam can provide estimates of relative risks that are useful in design and decision analysis and can avoid compounding of conservatism. (See also W91-05869) (Author's abstract)
W91-05868

EARTHQUAKE-INDUCED PERMANENT DEFORMATIONS: PROBABILISTIC APPROACH.
Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
M. K. Yegian, E. A. Marciano, and V. G. Ghahraman.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 1, p 35-50, January 1991. 10 fig, 2 tab, 23 ref. National Science Foundation Grant No. DFR-84-12124.

Descriptors: *Deformation, *Earth dams, *Earthquakes, *Hydraulic engineering, *Probabilistic process, *Seismic surveys, Computer programs, Embankments, Hydraulic structures, Model studies, Performance evaluation, Risk assessment, Safety, Seismology, Slope stabilization.

A simple procedure for estimating earthquake-induced permanent deformations of earth dams, embankments, and slopes has been developed. The analytical model is based on computed permanent deformations obtained by using Newmark's sliding-block analysis and actual recorded acceleration time histories. The model incorporates the effect of earthquake magnitude through the use of equivalent uniform cycles of motion. Uncertainties in the model and the parameters used are accounted for through the use of modeling error theory. Normalized plots and a computer program are used to provide the probability that the permanent deformation of a critical sliding mass will exceed a specified value. The results from this probabilistic procedure can be expressed in terms of damage probabilities in the form of a seismic performance analysis matrix. (See also W91-05868) (Author's abstract)
W91-05869

RAPID WATER CONTENT BY COMPUTER-CONTROLLED MICROWAVE DRYING.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 8G.
W91-05871

DESIGN OF STORAGE TANKS FOR WATER HARVESTING IN RAINFED AREAS.
Dryland Research Station, Hoshiarpur (India).
H. N. Verma, and P. B. Sarma.
Agricultural Water Management AWMADF, Vol. 18, No. 3, p 195-207, September 1990. 4 fig, 4 tab, 9 ref.

Descriptors: *Agricultural water, *India, *Storage tanks, *Water harvesting, *Water storage, *Water tanks, Computer-aided design, Cost-benefit analysis, Design criteria, Punjab.

The design of water harvesting tanks and supplemental irrigation systems is highly location-specific and, thus, makes it very difficult to develop a general model which can be used for all areas. A procedure for the design of water harvesting tanks for rainfed farming in northern Punjab, India, was developed which can be modified and used for other rainfed areas. It was observed that the total cost of tank per unit of capacity decreased with increasing tank capacity. For maximum benefit the tanks should be designed on the basis of lowest assured runoff for presowing irrigation to wheat. The appropriate probability level of lowest assured runoff for tank design increases with increasing catchment area and varies from 40 to 80%. The benefit-cost ratio of such tanks varied from 1.60 to 4.56 for catchment areas 1 to 100 ha. (Author's abstract)
W91-05930

8B. Hydraulics

METHOD OF TRANSIENT ANALYSIS OF THREE-DIMENSIONAL DAM-RESERVOIR INTERACTIONS.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
C. S. Tsai, and G. C. Lee.
Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 116, No. 10, p 2151-2172, 1990. 14 fig, 45 ref, append. NSF-National Center for Earthquake Engineering Research Grant ECE8607591.

Descriptors: *Dam stability, *Dam-reservoir interactions, *Earthquake engineering, *Structural engineering, *Transient analysis, Dams, Finite element method, Mathematical analysis, Reservoirs.

The nonlinear behavior of dam-reservoir interactions is not well understood, especially when the system is formulated as a three-dimensional problem. One of the major difficulties is a lack of time-domain transmitting boundary for the far field (extending to infinity in the fluid domain). An efficient time-domain analysis procedure for a three-dimensional fluid-structure system based on a semianalytical method was developed that takes into consideration the radiated waves in the far field. The cross section of the far field, which may have an arbitrary shape, is assumed to extend uniformly to infinity in the upstream direction. The irregular near field with arbitrary geometric shape and boundary conditions is modeled using the conventional finite element method. Accuracy of the proposed method is established by comparing the numerical results with piecewise exact form of analytical solutions for a vertical rigid dam with vertical valleys subjected to actual earthquake and ramp loadings. In the proposed method, all of the procedures are processed directly in the time domain, which is efficient for nonlinear analyses of dams with infinite reservoirs formulated as a three-dimensional problem. (Author's abstract)
W91-05124

RED RIVER WATERWAY, REVISED OUTLETS FOR RED RIVER LOCKS: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2J.
W91-05272

ABSTRACTS OF THE SECOND INTERNATIONAL SYMPOSIUM ON GAS TRANSFER AT WATER SURFACES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2A.
W91-05273

PREDICTION OF THE DESTRUCTION OF THE BANKS OF THE CHEBOKSARY RESERVOIR AS A RESULT OF A RISE OF THE LEVEL.
For primary bibliographic entry see Field 2J.
W91-05301

CALCULATIONS OF SWINGING OF THE FLOW IN TRAPEZOIDAL CHANNELS.
A. B. Maslov, and D. A. Yusupov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 131-135, 1990. 4 fig, 7 ref.

Descriptors: *USSR, Hydraulic engineering, *Channel flow, *Flow models, *Transition flow,

Hydraulic jump, *Hydraulic models, *Channel morphology, Flow channels, Flow characteristics, Flow measurement, Canals, Turbulent flow, Eddies, Flow velocity, Canal design, Froude number, Water depth.

The most important stage in the design of new and reconstruction of existing water management systems is hydraulic calculation of the water-conveyance channels under their various operating regimes. The most complex is the calculation of the unsteady motion of a rapid flow in the transition sections of pools, where a marked change occurs in the longitudinal slopes of fast-flowing canals. Transformation of a rapid flow into a tranquil flow in the transition sections of trapezoidal channels has an extremely unstable swinging character, causing increased turbulence in the eddy zones, large velocity gradients, and pressure differences. Hydraulic calculations of flow swings in trapezoidal channels (canals) show that a rapid swinging flow (free hydraulic jump) is analogous in its destructive force to an unsubmerged hydraulic jump in a rectangular channel. Therefore, the length of the transition section of the pools should be maximally reduced by increasing the natural depth in the canal. An increase of the depth of the lower pool with increase of the Froude number is explained by an increase of the kinetic energy of the rapid swinging jet, leading to an increase of the second conjugate depth of the hydraulic jump. The values of the actual bottom velocities along the channel line and along the boundary of the rapid swinging jet differ substantially. The total mean vertical load on the slabs of the canal under three-dimensional conditions of transition of the pools in the general case is equal to the volume indicated by the pressure deficit diagram. The length of the apron part of the canal can be determined from the location of the eddy region of swinging of the flow, after determining the length of the stretch where the standard deviation of the pressure fluctuation stabilizes, and comparing the values. (Fish-PTT)
W91-05314

GENERALIZED LAGRANGIAN MODEL FOR BUOYANT JETS IN CURRENT.
Hong Kong Univ. Dept. of Civil and Structural Engineering.
J. H. W. Lee, and V. Cheung.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1085-1106, November/December 1990. 9 fig, 33 ref.

Descriptors: *Environmental engineering, *Wastewater outfall, *Jets, *Buoyancy, *Outfall sewers, Flow models, Tidal currents, *Water currents, Wastewater management, Wastewater disposal, Hydraulic engineering, Hydraulic design, Environmental impact, Mixing, *Model studies, Turbulent flow.

In shallow coastal waters, submarine outfalls are often designed so that adjacent wastewater plumes do not interfere before they surface or reach the terminal height of rise. By orienting the jet discharge horizontally into a perpendicular alongshore tidal current (and hence increasing the distance of travel for a given vertical rise of the jet), optimal mixing of the wastewater effluent can be achieved. Since a tidal current is present for the greater part of the time, it is often desirable to take into account the effect of an ambient current in outfall design and environmental impact assessment. However, the mixing of a deflected turbulent buoyant jet in a current is a much more complicated problem. A general Lagrangian jet model formulation has been developed for an inclined buoyant jet in a current, with a three-dimensional trajectory. The shear-induced entrainment was computed as a function of the local densimetric Froude number and jet orientation, while the forced entrainment was taken as the ambient flow intercepted by the 'windward' side of the buoyant jet. Model predictions were compared with both trajectory and tracer concentration data for a wide range of discharge and ambient flow conditions (horizontal buoyant jets in a coflow; vertical jets, oblique jets, and dense plumes in a cross flow; buoyant jets in a stagnant uniform or stratified fluid; and a horizontal buoyant jet in a perpendicular cross flow), and found to be valid. The model is also consistent with the concept of asymptotic flow regimes, and reproduces the correct behavior in both the near and far field of a vertical momentum of buoyancy-dominated jet in a cross flow. (Fish-PTT)
W91-05323

VELOCITY AND DEPTH OF FLOW CALCULATIONS IN PARTIALLY FILLED PIPES.
Marmara Univ., Istanbul (Turkey). Dept. of Engineering.
A. Saatci.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 6, p 1202-1208, November/December 1990. 3 fig, 1 tab, 1 ref.

Descriptors: *Environmental engineering, *Computer-aided design, *Sewer systems, *Hydraulic design, *Flow equations, Pipe flow, Pipes, Mannings equation, Design criteria, Hydraulic models, Flow velocity, Flow models, Flow characteristics, Critical depth, Mathematical equations.

Sewer design is usually based on a selected formula that can represent the flow conditions in partially filled pipes. Manning's formula is the most commonly used equation in sewer design practice because of its simplicity and the availability of numerous nomographs and tables. However, the routine calculations or the use of nomographs and tables can be a time-consuming task. Different computer programs have been introduced to minimize the laborious calculations. In either method of approach, the calculation procedures involve the determination of important design parameters, such as minimum slope, actual and full-flow velocities, actual and full-flow rates, and the depth of flow. Calculation of actual velocity and depth of flow using computers requires the application of iterative techniques. An algebraic equation that simplifies the velocity and depth of flow calculations in partially filled sewers has been developed. This equation is only valid if the water surface angle is less than or equal to 265 degrees. It is expected that the proposed equation will facilitate the laborious calculations required to study different design alternatives in partially filled pipes. The suggested equation was successfully applied to an example problem and the results compared closely with the exact solutions. (Fish-PTT)
W91-05329

INTERFACIAL MIXING CAUSED BY TURBULENT BUOYANT JETS.
Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
H. J. S. Fernando, H. Johnstone, and F. Zangrando.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 1-20, January 1991. 12 fig, 5 tab, 18 ref.

Descriptors: *Boundary processes, *Buoyant jets, *Entrainment, *Fluid dynamics, *Mixing, *Outfall, *Path of pollutants, *Turbulent flow, *Wastewater disposal, Buoyancy, Fluid mechanics, Jets, Mathematical models, Model studies, Theoretical analysis.

Laboratory experiments were carried out to investigate mixing and entrainment induced by a planar turbulent buoyant jet impinging on a stable density interface. The jet was released horizontally into the homogeneous bottom layer of a fluid system in which the top linearly stratified layer was separated from the homogeneous layer by a density discontinuity. This flow configuration has similarities to those that occur in solar ponds and ocean thermal energy conversion plants. The results reveal markedly different entrainment mechanisms, and thus entrainment laws, for different jet regimes that depend on the inlet buoyancy of the jet. Measurements included the entrainment velocity, interfacial-layer thickness, and time evolution of vertical density profiles. Based on observations of entrainment mechanisms, simple theoretical models were developed to predict entrainment laws for slightly buoyant and neutrally buoyant jet regimes, and the model predictions are compared with the experimental results. Within the error margins of the experiments, the model predictions were in satisfactory agreement with the experimental results. (Author's abstract)
W91-05419

SIMULATION OF FLOOD WAVES FROM OUTBURST OF GLACIER-DAMMED LAKE.
Instituto Nacional de Ciencia y Tecnica Hidricas, Mendoza (Argentina).
For primary bibliographic entry see Field 2E.
W91-05421

SUPERCRITICAL FLOW IN SMOOTH OPEN CHANNELS.
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.
K. V. N. Sarma, and P. Syamala.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 54-63, January 1991. 3 fig, 1 tab, 23 ref.

Descriptors: *Flow friction, *Froude number, *Open-channel flow, *Reynolds number, *Supercritical flow, *Turbulent flow, Darcy-Weisbach equation, Hydraulics, Mathematical models, Open channels, Subcritical flow, Unsteady flow.

The effect of Reynolds number and Froude number on the Darcy/Weisbach friction factor was studied for supercritical turbulent flow in smooth rectangular open channels. The values of Froude numbers for various aspect ratios, beyond which the flow becomes unstable, were determined using the method of Berlamont and Vanderstappen and the measured momentum coefficients. For a certain range, the effect of the Froude number is to increase the friction factor by a constant amount. For stable supercritical flows, the friction factor varies with Reynolds number only, as in the case of subcritical flows. For unstable supercritical flows, the friction factor was found to vary according to Rouse's equation. As the flow becomes unstable, the friction factor becomes consistently higher than that for stable flows. (Geiger-PTT)
W91-05422

FORCE ON SLAB BENEATH HYDRAULIC JUMP.
Urmia Univ. (Iran). Dept. of Irrigation.
J. Farhoudi, and R. Narayanan.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 64-82, January 1991. 17 fig, 17 ref.

Descriptors: *Hydraulic jump, *Mathematical models, *Open-channel flow, *Stilling basins, *Water pressure, Flow measurement, Fluid mechanics, Froude number, Hydraulic design, Hydraulic engineering, Open channels, Turbulent flow.

The mean and fluctuating forces exerted on the slab beneath the free hydraulic jump were measured on slabs of various lengths and widths and at Froude numbers of the upstream flow varying from 4.0 to 10.0. The intensity of force fluctuations on an area of slab beneath a hydraulic jump depends on its length and width, and on its position from the toe of the jump. Experimental results show that the transverse scale of pressure producing patterns of the turbulent hydraulic jump is longer than the streamwise scale. The scales of these patterns vary with the Froude number of the flow and the position within the jump. The probabilities of the force fluctuations were negatively skewed for the slab near the toe of the jump and positively skewed towards the downstream part of the jump. The results with respect to large slabs are presented in a form that would help in estimating the intensity of force fluctuations and be useful to designers of stilling basins. (Author's abstract)
W91-05423

EFFECT OF ROUGHENED-BED STILLING BASIN ON LENGTH OF RECTANGULAR HYDRAULIC JUMP.
Toyohashi Univ. of Technology (Japan). Dept. of Civil Engineering.

H. S. Mohamed Ali.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 83-93, January 1991. 9 fig, 2 tab, 10 ref.

Descriptors: *Channel flow, *Froude number, *Hydraulic design, *Hydraulic jump, *Hydraulic roughness, *Stilling basins, Channel morphology, Economic aspects, Flow measurement, Hydraulic properties, Irrigation design, Mathematical models.

The rectangular hydraulic jump downstream of low-head irrigation structures was studied on a rough channel bed under different flow conditions to obtain the optimum length of roughness from both the hydraulic and the economic point of view. Laboratory experiments showed that the length of hydraulic jump is clearly reduced by using cubic roughness. Decreasing the ratio of the length of roughened bed to height of cubic roughness improves the efficiency of the stilling basin by decreasing the relative length of jump; at a certain value of this ratio, the relative length of jump will be minimum. The effective relative length of roughness (ratio of length of roughened bed to height of cubic roughness = 28) provides a remarkable reduction in the relative length of jump (ratio of length of hydraulic jump to initial depth of jump). This reduction ranges from about 27.4% to about 67.4% for initial Froude numbers ranging from 10-4. The percentage reduction in length of jump using bed roughness decreases with increasing initial Froude number, provided that the most efficient design is used for a stilling basin. (Geiger-PTT)
W91-05424

RESISTANCE IN FLAT-BED SEDIMENT-LADEN FLOWS.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Hydromechanik.
For primary bibliographic entry see Field 2E.
W91-05425

CULVERT FLOW IN SMALL DRAINAGES IN MONTANE TROPICAL FORESTS: OBSERVATIONS FROM THE LUQUILLO EXPERIMENTAL FOREST OF PUERTO RICO.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2E.
W91-05635

TIDAL HYDRAULICS OF SAINT JOHN RIVER.
Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (Mexico).
For primary bibliographic entry see Field 2L.
W91-05783

LAGRANGIAN MOTIONS IN SIMPLE KINEMATIC OSCILLATORY FLOW FIELD.
Delaware Univ., Newark. Coll. of Marine Studies.
K.-C. Wong.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 1, p 29-43, 1991. 6 fig, 10 ref. National Science Foundation grant OCE-8822969.

Descriptors: *Fluid flow, *Fluid mechanics, *Kinematic waves, *Model studies, *Oscillating flow, *Waves, Frequency analysis, Oscillatory waves.

There are two ways to describe the motions of a fluid: to examine the flow property at fixed points within the space occupied by the fluid (Eulerian), or to follow each fluid parcel as it flows through space (Lagrangian). A kinematic approach was taken to examine analytically the Euler-Lagrange transformation and the basic behavior of fluid parcel trajectories associated with a monochromatic oscillatory current field having progressive wave characteristics. This study examined (1) the dependency of the Lagrangian motions on the initial release conditions; and (2) the distinction between the Eulerian and Lagrangian time scales and its implications on the residual Lagrangian flow field. It was found that, while the instantaneous trajectory of a labeled parcel depended strongly on the initial conditions, the appropriate period in the Lagrangian framework (T-lag) and the residual Lagrangian drift over such a period were independent of the initial conditions. Because T-lag and the Eulerian time scale (T-eu), defined as the period of the oscillatory Eulerian current, may be quite different, the residual Lagrangian drift over a complete T-eu may show strong dependency with the initial release conditions. It was also found that, while the Eulerian current was monochromatic, the Lagrangian trajectory exhibited multiple harmonics, with components at both higher and lower frequencies relative to the fundamental frequency. (Author's abstract)
W91-05784

WAVE FORCES ON A WALL.
Coastal Engineering Research Center, Vicksburg, MS.
F. E. Camfield.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 1, p 76-79, 1991. 2 fig, 8 ref.

Descriptors: *Coastal engineering, *Hydraulic engineering, *Hydraulic structures, *Sea walls, *Wave action, Shores, Wave runup.

It is often necessary to compute wave forces on coastal structures located adjacent to shorelines. Such structures are subjected to the force of waves running up on the shoreline, and impacting on the structure. A need exists to update the method for determining wave force described in the Shore Protection Manual (SPM) of 1984, to incorporate additional information on runup and surge forces, and to obtain a more reasonable solution for the wave force. A methodology has been developed for broken waves, i.e., it is assumed that the wave will not reform into a nonbreaking wave between the breaking point and the shoreline, on slopes exceeding 1% and assuming a natural shoreline with a slope not exceeding 10%. Only the total force is calculated; the pressure distribution would require additional experimental investigations. (Fish-PTT)
W91-05785

8C. Hydraulic Machinery

CONTROL OF THE PUMPED WATER SUPPLY TO WIGGINS WATERWORKS.
Umgeni Water Board, Pietermaritzburg (South Africa).
For primary bibliographic entry see Field 5F.
W91-05284

AUTOMATION OF THE WATER SUPPLY SCHEME ON THE OFS GOLDFIELDS.
Gold Fields Water Board, Bothaville (South Africa).
For primary bibliographic entry see Field 5F.
W91-05285

INSTRUMENTATION FOR ROOIWAL WATERCARE WORKS.
Meiring and Partners, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W91-05289

CHEMICAL PHOSPHATE REMOVAL AT BOKSBURG WATER POLLUTION CONTROL WORKS: AUTOMATION AND CONTROL.
Boksburg Town Council (South Africa).
For primary bibliographic entry see Field 5D.
W91-05290

EFFECT OF CHANGES IN THE GEOCRYOLOGICAL CONDITIONS IN THE BASIN OF RESERVOIRS ON FUNCTIONING OF NORTHERN HYDROELECTRIC STATIONS.
L. I. Kudoyarov, and T. S. Onikienko.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 55-60, 1990. 3 fig, 3 ref.

Descriptors: *USSR, *Water yield, *Hydraulic engineering, *Hydroelectric plants, *Permafrost, *Reservoir operation, Reservoir design, Geologic control, *Frozen ground, Ground ice, Geological surveys, Geohydrology, Cryology, Frost heaving, Frost thrusting, Engineering geology.

Experience in operating hydroelectric stations in permafrost regions of the U.S.S.R. shows that change in the geocryological (frozen-ground) conditions of river valleys under the effect of reservoirs leads to deformation of the reservoir bed, water loss due to seepage, and a decrease of the normal pool level and of the capacity and production of the hydrostations. The existing methods of calculating the water-power indices used in the design stage require preassigned parameters of the reservoir (volumes, areas) and do not take into account the effect of geocryological changes of the reservoir basin during formation. The effect of these changes on hydrostation functioning was studied at three hydro developments in the permafrost region of the U.S.S.R. It was found that the lack of experience in reservoir operation during hydropower development of the Far North territory in the 1960s caused a number of factors regarding reservoir formation to be overlooked, affecting the production and capacity of the hydrostations. At the feasibility and design stages of hydrostation construction in the northern regions it is necessary to use a new methodological approach based on consideration of the hydrological, geocryological, hydrogeological, and other site-specific conditions of the planned reservoirs and space-time changes in these conditions during their operation. Engineering-geological surveys must be conducted in regions where hydrostations are planned in the Far North for reliable predictions of engineering geocryological processes, changes in the hydrogeological conditions during formation of reservoirs, and provision of the design areas of the right-of-way and hydropower indices of the hydro developments. (Fish-PTT)
W91-05300

METHODOLOGICAL AND ORGANIZATIONAL CHARACTERISTICS OF SURVEYS FOR SMALL HYDROELECTRIC STATIONS.
S. I. Skiba.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 69-72, 1990. 3 ref.

Descriptors: *USSR, Hydraulic engineering, *Project planning, *Hydroelectric plants, *Surveys, *Hydraulic design, Design criteria, Geological surveys, Mountain streams, Environmental impact, Reservoir siting, Baseline studies, Engineering geology, Estimated costs.

Increasing development of small hydroelectric power engineering projects requires reexamination of the main methodological and organizational techniques of surveys for small hydrostations (characterized by capacities from 0.5-1.0 to 30 MW, and small and comparatively simple structures such as arch dams with a height up to 60 m, channels on slopes, tunnels under complex geological conditions, aqueducts, sag pipes, etc.). The majority of small hydrostations will be examined anew by the All-Union Planning, Surveying, and Scientific-Research Institute. Some general principles which should be considered during the survey include the following. Unpredicted processes complicating construction or operation and often leading to failures are known precisely for small hydraulic structures, and must be recognized. Practice has shown the error of 'a priori' assignment of estimated survey costs for hydropower facilities. Engineering-geological substantiations for small hydrostations at the development stage should be realized without the difficult exploratory works. The main design and construction stages are the most important ones for small hydrostations because the design stage, as a rule, is absent and the working design begins at the next stage. Mountain rivers, where concentrated falls and the possibility of creating reservoirs with minimum flooding and subirrigation areas are combined, are most prospective for constructing small hydrostations. Some unpopulated stretches of the valleys of mountain rivers have favorable natural conditions for creating seasonal reservoirs which increase the efficiency, capacity, and production. Under cur-

rent conditions it is necessary to find new ways to organize surveys for small hydrostations, with mobile, economically-independent parties. (Fish-PTT)
W91-05303

ICE CONDITIONS IN POOLS OF THE DAM OF THE KOLYMA HYDROELECTRIC STATION DURING INITIAL OPERATION.
For primary bibliographic entry see Field 2C.
W91-05309

STATE AND PROBLEMS OF ON-SITE OBSERVATIONS AT HYDRO DEVELOPMENTS BY GEODETIC MEASUREMENTS.
A. A. Karlson.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 108-112, 1990. 10 ref.

Descriptors: *USSR, Hydraulic engineering, *Hydroelectric plants, *Structural engineering, *Strain measurement, *Geological surveys, Structural settlement, Structural behavior, Deformation, Hydraulic structures, Dams, Reservoirs, Foundation rocks.

On-site observations by geodetic methods are carried out on a large scale at all hydro developments in the U.S.S.R. being constructed and at the majority of those in operation. The main task of geodetic measurements is an objective evaluation of the state of the structure and its working conditions, and information about the development of undesirable processes. An evaluation of the state of a structure with the use of measurement results was carried out by comparing the measured deformations (settlements, horizontal displacements) with those expected, using the maximum allowable indices (MAIs). The accuracy of calculating the MAIs and reliability of evaluating the state of hydraulic structures will be increased considerably if not only the total deformations but also their components caused by individual factors, as well as the regularities of their change with time, were determined. Geodetic measurements at large hydro developments have made it possible to reveal and evaluate certain processes in rock which earlier were unknown or not taken into account in calculations during design, such as a rise of the foundation and territory adjacent to the dam, or a change in the distance between banks during reservoir operation. Measurements of deformations make it possible to check construction quality, theoretical premises and mathematical formulas given in the design, and to determine the region of interaction of the dam and the reservoir with the environment. There are many problems in on-site observations by geodetic methods at hydro developments whose solution can substantially increase the quality of geodetic measurements and will make it possible to more reliably evaluate the state of hydraulic structures. (Fish-PTT)
W91-05310

GEODETIC INVESTIGATIONS OF DEFORMATIONS OF THE EARTH'S CRUST IN THE REGIONS OF THE NUREK AND ROGUN HYDROELECTRIC STATIONS.
For primary bibliographic entry see Field 8E.
W91-05311

STEAM FOGS IN LOWER POOLS OF HYDROELECTRIC STATIONS AND POSSIBILITIES OF THEIR ARTIFICIAL DISPERSION.
For primary bibliographic entry see Field 2C.
W91-05312

8D. Soil Mechanics

CALCULATED PREDICTION OF EARTH PRESSURES ON TAILWATER TUNNELS OF THE ROGUN HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8E.
W91-05076

WATER-HOLDING CAPACITY OF STRUCTURES MADE OF SAND-GRAVEL-PEBBLE SOILS.
V. F. Kanarskii, V. M. Kondrat'ev, V. A. Osadchuk, A. M. Padnya, and A. I. Svintsov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 10-13, 1990. 3 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 14-16, January, 1990.

Descriptors: *Earthworks, *Reservoirs, *Sand, *Soil physical properties, Design methods, Economic aspects, Facings, Gravel, Hydraulic engineering, Permeability, Sandy soils, Watertight construction.

The necessary water-holding capacity of structures made of sand with a flattened profile and with a foundation also composed of sand with a permeability coefficient (Kp) of 20-30 m/day can be provided without using watertight elements in the body. In contrast, the water-holding capacity of analogous structures on a high-permeability foundation (Kp > 30 m/day) can be provided by using watertight elements or by constructing the structures using appropriate technology. The design process required for construction of the body of the structure by hydraulic filling to achieve the necessary water-holding capacity was analyzed and the results applied to structures composed of gravel-pebbles. The water-holding capacity of structures composed of gravel-pebbles is provided by the placement of an upstream facing and apron, core and apron, and other watertight elements. The permeability coefficient of the compacted clay soil of the facing, apron, and core is determined by a method that considers the density and degree of deformation of the pores from compaction using a previously published method. The method was employed in the design and construction of the water-enclosing structures made of sand-gravel-pebble soils for the reservoir of the Terek-Malka hydro development. The economic effect of constructing the number 1 water-enclosing tank of sand without a watertight facing of loam on a stretch 8.5 km long was 1.07 million rubles. (Rochester-PTT)
W91-05078

OPTIMIZATION OF THE DESIGNS OF EARTH DAMS.
For primary bibliographic entry see Field 8A.
W91-05083

RELIABILITY OF THE ASSURANCE OF STABILITY OF EARTH MASSES.
V. N. Bukhartsev.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 51-54, 1990. 2 fig, 1 tab, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 41-44, January, 1990.

Descriptors: *Earthworks, *Structural engineering, *Structural stability, Dam stability, Mathematical analysis, Soviet Union, Standards.

The problem of estimating the reliability of earth mass structures is still little elaborated. Many problems, particularly standardization of the degree of reliability of large hydraulic structures are in need of serious investigation. A method is proposed for evaluating the reliability of earth masses, making it possible to use any method of evaluating stability with any method of finding the dangerous surface of sliding in combination with any stability criterion. The main task of the reliability calculation consists of calculating the probability that an unallowable limit state is not reached. Numerous random variables other than structural stability, such as seepage and earthquakes, are replaced by deterministic calculated values that are united into the most unfavorable, but nevertheless possible, combinations. Using as an example an overflow dam, it is shown that, for the given conditions, the degree of reliability is high despite the fact that the value of the stability factor is barely more than 1.20, even for P = 0.90. When P > 0.99, it is difficult to determine reliability because of the limitations of available official tables. The concept of 'reliability of preservation of a certain safety factor' is the probability that the object under consideration not only does not lose bearing capacity but keeps the safety factor assigned beforehand. This method provides continuity of reliability calculations with stability calculations regulated by the current building codes in the Soviet Union. (Rochester-PTT)
W91-05088

SETTLEMENT AND MOISTURE MOVEMENT IN COLLAPSIBLE SOILS.
Arizona State Univ., Tempe. Dept. of Civil Engineering.
M. El-Ehwany, and S. L. Houston.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 10, p 1521-1535, October 1990. 14 fig, 3 tab, 10 ref. NSF Grants CES87-08193 and BCS89-00838.

Descriptors: *Collapse, *Field tests, *Foundation failure, *Soil mechanics, *Wetting, Footings, Infiltration, Performance evaluation, Ponding, Structural engineering.

A high-quality prediction of collapse settlement depends strongly on an accurate estimate of the depth of the wetted zone. A study was conducted to predict and monitor the infiltration of surface ponded water below a footing. A full-scale footing was constructed at a collapsible soil site in Scottsdale, Arizona. The infiltration of ponded water beneath the footing on collapsible soil was monitored. Soil suction, water content, and footing settlement measurements were made. Laboratory infiltration tests were used to predict the extent of wetting in the field. Close agreement between observed and predicted extent of wetting was obtained. The in situ values of soil suction were quite high, corresponding to a pF value of about 5.26 (1,820 m of water) and degree saturation of about 15%. In response to ponding, soil suction dropped by a factor of about 10 behind the wetted front, but remained high, with pF 4-4.5 (100-316 m of water) and degree of saturation averaging about 50%. Laboratory collapse tests show that partial wetting produces only partial collapse, with 50% saturation producing about 85% of full collapse strain for the soil tested. Partial wetting is considered in making footing settlement predictions; the predicted settlement exceeds the observed settlement by only about 12%. It appears reasonable to expect close agreement, as in this case, when the extent of wetting is known in advance or well-predicted. (Author's abstract)
W91-05127

STABILIZING COMPACTED CLAY AGAINST CHEMICAL ATTACK.
New Haven Univ., West Haven, CT. Dept. of Civil Engineering.
G. P. Broderick, and D. E. Daniel.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 10, p 1549-1567, October 1990. 13 fig, 6 tab, 33 ref.

Descriptors: *Clays, *Landfills, *Liners, *Organic chemicals, *Sealants, *Soil stability, *Waste disposal, Clay minerals, Hydraulic conductivity, Lime, Portland cements, Sodium silicate, Soil mechanics.

Concentrated organic chemicals have been shown to cause large increases in the hydraulic conductivity of compacted clay. Mechanical and chemical methods of stabilizing four different types of compacted clay against chemical attack were investigated. Mechanical stabilization using a large compactive effort (measured by Proctor compaction) or application of compressive stress of at least 10 psi (70 kPa) rendered a compact clay invulnerable to attack by concentrated organic chemicals (acetic acid, ethanolamine, heptane, methanol, and trichloroethylene) under laboratory conditions. Attapulgite, a clay mineral having little electrical charge, was relatively unaffected compared to more common clay minerals such as kaolinite, illite, and smectite by organic chemicals. Addition of approximately 7% by weight of lime, Portland cement, or lime plus sodium silicate greatly improved the ability of the compacted clay to resist attack by concentrated organic chemicals. In some cases the amended soils were less permeable to

concentrated organic chemicals than the unamended soils were to water. (Author's abstract)
W91-05128

SOFT CLAY SOILS IN THE FOUNDATION OF HYDRAULIC STRUCTURES.
N. F. Aripov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 81-85, 1990. 4 fig, 3 tab, 3 ref.

Descriptors: *Clay soils, *USSR, Hydraulic engineering, *Foundation failure, *Hydraulic structures, *Soil dynamics, Engineering geology, Rigid foundations, Compacted soils, Saturated soils, Permeability, Soil physical properties, Pore pressure, Slope stability, Soil stability, Clays.

Soft water-saturated clay soils are those which have a modulus of total deformation equal to or less than 5 MPa and are characterized by a degree of saturation more than 0.8 in between 0.05 to 0.3 MPa pressure. They possess low strength indices, high compressibility, and small permeability. As a consequence of this, long and often nonuniform stabilization of settlements in structural foundations cause great complications during construction and operation of the structures. However, it has been shown that with appropriate engineering measures, soft water-saturated clay soils can be a completely reliable foundation. One of the main conditions of studying their properties is correct setup of the investigations themselves and interpretations of the experimental data obtained, taking into account both the construction technology and the structural parameters; occurrence and thickness of the investigated soft clay soils; and hydrogeological conditions. The piezometric head in the foundation is due not only to the hydrogeological conditions but also to the pore pressure of soil consolidation, due to compaction. The presence of pore pressure in clay soils of a foundation determines the stability of the dam slopes and deformation of structures with time. All investigations and interpretation of the results should be related to determination of predictive parameters of the soils both for the period of construction and operation of the structures. To obtain objective information about the state and properties of soils in the foundation of structures, experimental embankments are necessary along with the conventional investigations of undisturbed soils in laboratory and field investigations in situ (penetration, vanes, plates). Consideration of these circumstances when designing hydraulic structures in the U.S.S.R. will make it possible to make more substantiated economic decisions. (Fish-PTT)
W91-05305

RESULTS OF ON-SITE OBSERVATIONS OF LANDSLIDE SLOPES OF THE ZAGORSK PUMPED-STORAGE STATION AND RELIABILITY OF GEOLOGICAL FORECASTS.
T. E. Baranova, I. A. Kraseva, and A. I. Yudkevich.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 86-92, 1990. 4 fig, 1 tab.

Descriptors: *USSR, Hydraulic engineering, *Hydroelectric plants, *Engineering geology, *Landslides, Geological surveys, Clays, Geologic fractures, *Pumped storage, Geohydrology, Slope stability, Reservoir operation, Elastic properties, Soil creep, Hydraulic structures, Drainage engineering, Reservoir construction.

Pumped-storage stations (PSSs) are highly complex from an engineering-geological viewpoint. The flatland Zagorsk PSS, located 30 km north of the city of Zagorsk, in the basin of the Volga River, is the first such structure in the U.S.S.R. The presence of the rather persistent thin interlayer of 'green clays' determined the formation of several slip blocks, which were cut away and replaced with a counter berm and drainage devices. Hydrogeological observations have been carried out for one year on stretches of the landslide slopes to monitor the temporal change in the stability of the slopes, and to establish the most efficient methods of operating the structure. Observations show the rather effective operation of the drainage systems. Filling of the reservoir caused an increase of the rate of deformations of the slope up to 0.4 mm/day with a diminishing tendency. Reverse development of this deformation occurred after rapid emptying of the reservoir, because of its 'elastic' (pseudoelastic) character. The rate of secondary creep during initial operation is 0.02-0.03 m/day, indicating that the slope is stable, and the stability factor is practically equal to that before the start of construction, but is greater than that of the period of construction of the landslide-control toe wall. The experience in studying, monitoring, and forecasting the stability of slopes with consideration of technogenic factors obtained during construction and startup of the Zagorsk PSS is of great practical significance for the general design and construction of flatland PSSs and should be taken into account and used in methodological standards. (Fish-PTT)
W91-05306

LANDSLIDE AT THE ABUTMENT OF THE DAM OF THE MINGECHAUR HYDROELECTRIC STATION.
A. I. Kotyuzhan, and L. A. Molokov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 92-95, 1990. 2 fig, 1 tab.

Descriptors: *USSR, Hydraulic engineering, *Landslides, *Hydroelectric plants, *Engineering geology, *Slope stability, Water level fluctuations, Reservoir operation, Dam foundations, Weathering zone, Stress analysis, Soil creep, Rock properties, Geologic control, Sediment control, Erosion control, Karst.

On August 23, 1989, a landslide occurred at the upper pool of the dam of the Mingechaur (U.S.S.R.) hydroelectric station, preceded by a heavy rain (78 mm in 24 h). After creating the reservoir with water level fluctuations within elevations 72-83 m, the middle and upper parts of the slopes were exposed to the development of landslide processes. It is known that landslide deformations are caused by changes in the stress state due to reworking of the banks, undercutting of the slopes, hydrodynamic forces, worsening of the physical and mechanical properties of argillaceous rocks due to weathering, additional wetting by infiltration precipitation through karst fissures, and as a consequence of creep of clays. Because of these conditions, a commission of the Ministry of Power and Electrification recommended the following immediate priority measures: (1) cutting away the potentially unstable rocks above elevation 230 m; (2) cutting away the slide masses of the upper and middle parts of the slope; and (3) restoration of the lower part of the slope and slopes of the intake basin. After performing the priority works, it will be necessary to implement landslide-control measures providing general stability of the slopes during the entire period of operation of the hydraulic structures, such as: cutting away the crest to elevations of 210-220 m, flattening the upper and lower parts of the slope, construction of a counter berm in the lower part of the slope, construction of a storm drain, and filling of all karst cavities in this stretch. (Fish-PTT)
W91-05307

FOUNDATION CONSTRUCTION WITHIN WASTEWATER-TREATMENT PLANT.
Hampton (Delon) and Associates, Washington, DC.
D. Hampton, J. S. Jin, and E. A. Clark.
Journal of Construction Engineering and Management (ASCE) JCEMD4, Vol. 116, No. 4, p 564-573, December 1990. 4 fig, 1 tab, 3 ref.

Descriptors: *Foundations, *Rigid foundations, *Piles, *Structural engineering, *Construction methods, *Wastewater facilities, Design criteria, Bases, Projects, Dewatering, Load distribution, Civil engineering, Soil strength, Saturated soils, Structural settlement, Georgia.

It was recently necessary to expand and upgrade the Poplar Street Water Pollution Control Plant located in Macon, Georgia. Weak soils existed to significant depths over the entire site as did a high groundwater table. New facilities had to be constructed on or in soft soils below the water table without damaging or impairing the operation of existing structures on the site. A field monitoring and observation program was implemented to validate the design assumptions, to assess construction impacts on existing structures, and to provide data from which decisions could be made relating to changes in construction procedures or methods as dictated by performance. Since the elevations of the bases of the structures varied significantly, it was cost-effective to vary foundation type depending upon the estimated load-carrying capacity of the soil at the base of the proposed foundations. Consideration also had to be given to the possibility of detrimental total and differential settlements as a result of dewatering as well as differences in foundation type between existing and proposed structures. This project demonstrated that a properly designed and adequately executed foundation construction program can effectively eliminate the need for expensive underpinning of nearby existing facilities. The pile load test is a reliable tool to establish the driving criteria, to confirm the design assumptions, and to economize the required pile length. (Fish-PTT)
W91-05317

PERMEABILITY ANISOTROPY OF NATURAL CLAYS AS A FUNCTION OF STRAIN.
Laval Univ., Quebec. Dept. of Civil Engineering.
S. Leroueil, G. Bouclin, F. Tavenas, L. Bergeron, and P. La Rochelle.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 568-579, October 1990. 15 fig, 1 tab, 23 ref, append.

Descriptors: *Permeability, *Clays, *Soil tests, *Strain measurement, *Compressibility, Foundation failure, Embankments, Hydraulic conductivity, Void ratio, Permeameters, Anisotropy, Marine sediments, Silty soils.

When a clay foundation settles under an embankment, its void ratio decreases with a resultant reduction of the permeability (hydraulic conductivity). Seven series of tests were performed on specimens from five natural soft clay sites, using a radial-flow permeameter and triaxial and odeometer cells, to determine the variation of the vertical and horizontal permeabilities when the soil is unidimensionally compressed. Results showed that permeability anisotropy does not increase significantly with compression up to strains of 25% for marine clays. In varved clays, because the clay laminae are more compressible than the silty laminae, the anisotropy increases with vertical compression. (Author's abstract)
W91-05359

MODELLING SPATIAL VARIABILITY OF SOIL PARAMETERS.
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
M. Soulie, P. Montes, and V. Silvestri.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 617-630, October 1990. 21 fig, 15 ref, append.

Descriptors: *Soil physical properties, *Model studies, *Geostatistics, *Soil mechanics, Clays, Soil strength, Quebec, Canada, Shear, Spatial distribution, Anisotropy, Kriging, Soil structure, Error analysis, Estimating equations, Mathematical models, Broadback River.

The undrained shear strength of a clay deposit represents one of its most important mechanical properties. The dispersion of each measurement of the undrained shear strength about its average value, and the spatial variability, are natural phenomena whose analysis leads to a better understanding of the short-term behavior of soft clay soils. It has been found that the vane test, used in the last 20-30 years, can allow estimates of the undrained shear strength to be too high. Geostatistics can help in finding the structure of the spatial variability of the undrained shear strength within a clay deposit. A site on the shore of the Broadback River in the James Bay area of Quebec, Canada, was studied to develop an applicable geostatistical model. Geostatistical analysis was carried out on

the unaltered zone of the clay; it shows an anisotropic structure for the spatial variability. Knowledge of the structure (variogram) of the undrained shear strength was used in the kriging theory to compute estimations at points of the deposit where experimental measurements were not available. Kriging was also used to identify weak zones within the clay. It may be concluded that, even when errors of measurements were small, the variogram permitted the detection and correction of a bias that affected a certain number of vane profiles. (Fish-PTT)
W91-05361

FACTORS CONTROLLING DEBRIS AVALANCHE INITIATION.
British Columbia Univ., Vancouver. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W91-05364

PERFORMANCE DATA FOR A SLOPED REINFORCED SOIL WALL.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
R. J. Fannin, and S. Hermann.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 676-686, October 1990. 14 fig, 5 tab, 14 ref.

Descriptors: *Reinforced soil structures, *Slope protection, *Slope stability, *Retaining walls, Performance evaluation, *Structural behavior, *Load testing, Soil creep, Strain measurement, Earth pressure, Load distribution, Stress-strain curves, Field tests, Strength.

Reinforced soil walls and slopes may be broadly distinguished by the manner in which force is mobilized in the reinforcing elements and the resultant profile of force along the length of the reinforcement. A sloped reinforced soil wall, comprising two sections with a different arrangement and spacing of geogrid reinforcement, was built and monitored for loading conditions of self-weight, a cycle of surcharge load, and permanent surcharge loading of the wall crest. Instrumentation was used to measure force and strain in the reinforcement, soil strain and temperature, and earth pressure for 20 months following completion of construction. It was found that interaction between the geogrid and soil agreed well with the existing understanding of behavior; a good interlock existed between the geogrid and the soil, and the distribution of observed strains showed strain magnitudes of zero close to the embedded end of the reinforcement, increasing to a maximum value close to the front of the slope where the reinforcement fixed to lightweight facing units. A nonuniform spacing of primary reinforcement was observed to promote a more uniform distribution of force in the layers of reinforcement. An appropriate plane strain value for the angle of soil friction, from analysis of direct shear tests, calculated theoretical values for the coefficient of active earth pressure which are in agreement with the field observations. Measurements of force and strain in the embedded reinforcement indicated values for a modulus of stiffness which are compatible with laboratory test data. A small amount of creep was observed to take place in the reinforcement, due to the relatively low magnitude of mobilized force in the reinforcement compared with the ultimate tensile strength. (Fish-PTT)
W91-05365

PIPING AND EROSION TESTS AT CONNER RUN DAM.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
G. A. Leonards, A. B. Huang, and J. Ramos.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 1, p 108-117, 1991. 5 fig, 3 tab, 1 ref.

Descriptors: *Dam design, *Erosion, *Filtration, *Hydraulic engineering, *Soil mechanics, *West Virginia, Clays, Compacted soils, Drainage engineering, Fly ash, Hydraulic gradient, Permeability, Plasticity, Reservoir sediments, Seepage, Soil properties.

Tests were conducted on the filtration characteristics of the chimney drain, and on the erodibility of the upstream clay blanket, at Conner Run Dam near Moundsville, West Virginia. It was found that the weathered clay shale with the lowest plasticity was the most susceptible to piping but plasticity had no apparent influence on the resistance to internal erosion. The sand filter prevented piping from occurring at the interface between the clay sample and its container at hydraulic gradients in excess of 240. Compaction reduces the potential for piping significantly. In pinhole tests, internal erosion commenced immediately, and was not arrested by the boiler slag filter at upstream water pressures corresponding to a water head of 55 m (maximum reservoir level). This corroborated the prediction that the boiler slag was too coarse to act as a filter. The permeability of the fly ash/clay system was more than an order of magnitude smaller when the fly ash was upstream of the compacted clay than when it was downstream. Drilling into and sampling the existing upstream clay blanket from the water line to a depth of 11 m (a vertical height corresponding to the thickness of the inclined blanket) showed the hole to be dry and the water contents of the samples to be comparable to the mean values of the placement water content, confirming laboratory tests which showed that the fly ash clogged the pores in the compacted clay and greatly reduced its permeability. It was concluded that fly ash in the reservoir would effectively control potential concentrated leaks in the clay core of Conner Run Dam. The fly ash also reduced seepage losses through the sides and bottom of the reservoir itself. (Fish-PTT)
W91-05870

EVALUATION OF CONSTRUCTED AND NATURAL SOIL MACROPORES USING X-RAY COMPUTED TOMOGRAPHY.
Missouri Univ.-Columbia. Dept. of Agronomy.
S. H. Anderson, R. L. Peyton, and C. J. Gantzer.
Geoderma GEDMAB, Vol. 46, No. 1/3, p 13-29, March 1990. 6 fig, 1 tab, 27 ref. USGS Award 14-08-0001-G1643.

Descriptors: *Computed tomography, *Macropores, *Measuring instruments, *Soil structure, Agriculture, Bulk density, Cultivated lands, Data acquisition, Performance evaluation, Soil cores, Soil density, Soil density probes, Soil properties, Statistical analysis.

Characterization of macropores (1-5 mm diam. holes) in undisturbed soils has been hindered by the lack of an easy, noninvasive method. The recently developed x-ray computed tomography (CT) scanners may provide a technique for the rapid, nondestructive analysis of macropores in undisturbed soil cores. Research was conducted to evaluate constructed and natural soil macropores using a Siemens DRH CT scanner. Undisturbed soil cores (76.4 x 76.4 mm) were removed from the A horizon of a Menfro silt loam (fine-silty, mixed, mesic Typic Hapludalf) soil of two adjacent sites. One site had been under continuous cultivation and the other under natural forest. Additional soil cores were packed to selected soil densities using sieved soil material from the surface horizon of the Menfro silt loam soil. Macropores were created by placing wires ranging from 0.5 to 5.0 mm diameter in the soil during packing and removing the wires prior to scanning. Bulk density, measured in 1 cu mm volumes, correlated well ($r=0.97$) with the size and location of the constructed macropores. Frequency distributions of bulk density measured in the undisturbed soil cores from the cultivated and forest sites were negatively skewed due to the low density within structural features of the cores. The mean skewness coefficients were -0.28 and -0.37 for the cultivated and forest cores, respectively. Analysis of bulk densities measured in transects within the cores using autocorrelation and partial autocorrelation functions suggested that bulk density was autocorrelated at small distances and could be described by a first-order autoregressive system. Results indicate that CT has good potential as a technique for evaluating structural characteristics in soils. (Author's abstract)
W91-05874

8E. Rock Mechanics and Geology

CALCULATED PREDICTION OF EARTH PRESSURES ON TAILWATER TUNNELS OF THE ROGUN HYDROELECTRIC STATION.
Y. K. Zaretskii, and I. U. Madzhidov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 1-5, 1990. 6 fig, 7 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 8-10, January, 1990.

Descriptors: *Dams, *Soil mechanics, *Tunnels, Earth pressure, Reinforced concrete, Rogun hydroelectric plant, Structural engineering.

The tailwater tunnels at the Rogun hydro development (USSR) consist of reinforced concrete culverts that pass under the downstream shoulder of the dam at a depth of 250 m. Nonuniform settling of the soil above the structure and side zones occurs due to substantially different deformability of the tunnel lining and fill. As a result, vertical slip surfaces form that are tangential to the structure and reach the level of equal settlement. Frictional forces occurring on these surfaces also load the soil mass above the structure. As a result of this effect, the vertical pressure on the structure exceeds the fill's own weight above the tunnel lining. Calculations were performed to evaluate the magnitude of this additional pressure and the effectiveness of engineering measures on their unloading. The method was based on calculating a series of two-dimensional problems with respect to the transverse and longitudinal sections of the tunnel based on the finite-element method and using triangular finite elements of second order as well as a mathematical model of soil. The method employed appears to be useful both for analyzing the expediency and effectiveness of various unloading measures and for refining the values of additional pressures occurring on structures in high embankments of dams, levees, and other earth structures. This method can be used in solving problems of the interaction of reinforced concrete structures with a soil mass not only to determine the contact stresses but to predict more accurately the stress-strain state of the structure and the optimum reinforcement of its elements. (Rochester-PTT)
W91-05076

EFFECT OF DILATANCY OF ROCKS ON RESISTANCE TO SHEARING LOADS.
V. N. Burlakov, and S. B. Ukhov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 5-9, 1990. 5 fig, 2 tab, 1 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 11-13, January, 1990.

Descriptors: *Rock properties, *Shear stress, Dilatancy, Friction, Performance evaluation, Plate experiments, Testing procedures.

The results of more than 200 plate experiments on shearing resistance in rocks have demonstrated that the ultimate resistance to shearing loads largely depends on processes of compression and decompression (dilatancy) occurring at the base in the shear zone. A method was developed and tested for conducting shear tests of plates and analyzing the results for determining three parameters, including the angle of internal friction and the limit resistance to slip (Nsl). The results of shear tests under field and laboratory conditions permit the conclusion that resistance to shearing loads largely depends on the parameter Nsl. Thus, resistance to shearing loads is a function of two variables: normal stresses (p) and the dilatancy parameter (Nsl), which can be taken as a characteristic of the direction of the slip surfaces in the limit state. Further experiments and analysis led to the conclusion that this relationship has a general character. (Rochester-PTT)
W91-05077

DIFFERENTIAL PRESSURE TILTMETER FOR LARGE-SCALE GROUND MONITORING.
Meier (Edi) and Partner, Winterthur (Switzerland).

For primary bibliographic entry see Field 8G.
W91-05121

LA VILLITA DAM RESPONSE DURING FIVE EARTHQUAKES INCLUDING PERMANENT DEFORMATION.
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
A. M. Elgamal, R. F. Scott, M. F. Succarieh, and L. Yan.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 10, p 1443-1462, October 1990. 20 fig, 2 tab, 15 ref.

Descriptors: *Dam stability, *Earthquakes, *Mexico, *Rockfill dams, Deformation, Earth dams, Instrumentation, La Villita dam, Measuring instruments, Seismographs, Shear stress, Sliding.

La Villita is a 60 m-high earth and rockfill dam located 350 km southwest of Mexico City, Mexico. Since its construction the dam has been subjected to six major earthquakes, five of which are believed to be responsible for significant localized deformation in the dam. The dynamic response of the dam to these shaking events was recorded by a strong-motion instrument located near the crest on a portion of the dam, which appears to move as a sliding block. In addition, permanent displacements after each earthquake were recorded and documented. In this investigation, it was found that the strong-motion records not only indicated localized deformations (partial incremental failure), but reveal as well the magnitude of the associated yield acceleration. The available crest records at La Villita reveal the yield-acceleration magnitude that was necessary to overcome shear strength and cause stick-slip-type sliding. Accumulation of stick-slip-type deformation such as that at La Villita is not unusual when strong earthquakes affect dams, retaining walls, and other structures. The presence of strong-motion instrumentation at the locations where sliding may occur will reveal additional information concerning the strength of these structures as inferred from any observed yield acceleration. Additional understanding of the characteristics and mechanisms involved in stick-slip deformation can be facilitated by the availability of enhanced acceleration records. (Rochester-PTT)
W91-05125

RELIABILITY MODEL FOR SOIL LINER: POSTCONSTRUCTION.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W91-05126

SYSTEM FOR DETERMINING THE DESIGN CHARACTERISTICS OF ROCK MASSES.
Y. A. Fishman.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 73-81, 1990. 2 fig, 11 ref.

Descriptors: *Rock mechanics, *USSR, Hydraulic engineering, *Hydraulic design, *Engineering geology, *Foundation rocks, Design criteria, Rock properties, Geological surveys, Structural models, Cost-benefit analysis, Mathematical models, Baseline studies, Physical models.

The reliability and cost-effectiveness of hydraulic structures depend on the accuracy of the foundation design characteristics; however, a reliable determination of geomechanical characteristics can only be obtained by conducting large-scale experiments, limited by the great complexity, high cost, long duration, and the validity of the results. To solve this contradiction, a system of geomechanical investigations is needed which would make it possible to determine the properties of rock masses with the required accuracy and reliability with minimum expenditures of means and time, using quantitative methods of analysis. Engineering-geological models (EGMs) should be constructed as a basis for calculations, physical modeling, and structural design; establishment of the range of characteristics required for the design; predictive evaluation of their values; optimization of investigations; selection and processing of representative plots; selection of standard and design values; their application to the rock mass; and routine monitoring of the foundation during construction and operation. The EGMs should reflect the regularities of the structure, state, and properties of the rock mass, which enables prediction of the engineering-geological conditions at any point; and the EGMs should schematize the natural conditions to the degree necessary for solving the stated problem: mathematical or physical modeling of structures, consideration of the characteristics of particular calculation methods, etc. In the next stage the required geomechanical parameters are established on the basis of a combined examination of the design and engineering-geological models (an analysis of the operation scheme of the structures, methods of their calculation, structure of the rock mass, and types of investigated rocks). (Fish-PTT)
W91-05304

RELATION BETWEEN PARAMETERS OF SEISMIC EFFECTS AND INTENSITY.
I. P. Kuzin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 96-104, 1990. 2 fig, 6 tab, 23 ref.

Descriptors: *USSR, *Structural engineering, *Seismology, *Seismic properties, *Earthquake engineering, Seismic intensity, *Earthquakes, Shock loads, Seismic waves, Hydraulic structures.

The intensity scale of a strong earthquake does not contain the quantitative information necessary for calculating the seismic stability of various structures. Therefore, investigators have attempted to establish a relation between ground motion accelerations and intensities. The shortcomings of previously-developed scales with respect to the effect of the duration and frequency of strong ground motions on the macroseismic effect were eliminated in the draft of a modification of the scale--the variant MMSK-86 proposed by the Institute of Physics of the Earth, Academy of Sciences of the U.S.S.R. However, this scale was developed on the basis of experimental samples truncated on both the side of the high level of shocks (intensity 8 or more) and low level (less than intensity 7). Therefore, the relationships between the kinematic parameters of ground motions and intensity 7-9 were examined on the basis of a single initial seismological parameter--the earthquake magnitude (M = the conventional index of the energy released at the earthquake focus, which corresponds to the common logarithm of the amplitude of ground motions). It was found that the highest acceleration values in intensity 7-8 zones refute the widespread fallacy that the highest accelerations in intensity 7-9 zones are due to the strongest earthquakes. The average acceleration for the intensity 9 zone according to the MMSK-86 scale is about 1.4 times too high. A nonuniformity of the step of the increase of accelerations is found, indicating that the expected seismic loads in the intensity 9 zone should be reduced by about 40%. With an increase of intensity from 7 to 9, the oscillation periods become shorter by about 1.75 times, possibly due to a decrease in the average radii of the isoseismals of maximum intensity with increase of its level and by the dominance of earthquakes of relatively small magnitudes in the formation of a high level of intensity and large values of the parameters of seismic effects. When calculating the stability of structures it is necessary to be oriented toward an increase of the frequency of oscillations and decrease of their duration with increase of intensity from 7 to 9. (Fish-PTT)
W91-05308

STATE AND PROBLEMS OF ON-SITE OBSERVATIONS AT HYDRO DEVELOPMENTS BY GEODETIC MEASUREMENTS.
For primary bibliographic entry see Field 8C.
W91-05310

GEODETIC INVESTIGATIONS OF DEFORMATIONS OF THE EARTH'S CRUST IN THE REGIONS OF THE NUREK AND ROGUN HYDROELECTRIC STATIONS.
A. P. Raizman.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 112-116, 1990. 5 fig, 4 ref.

Descriptors: *Dam effects, *USSR, Hydraulic engineering, *Strain measurement, *Hydroelectric plants, *Geologic surveys, *Deformation, Subsidence, Dams, Reservoirs, Hydraulic structures, Structural engineering, Bench marks, Water level fluctuations, Engineering geology.

Investigations of deformations of the earth's crust, by geodetic methods, in the regions of the Nurek and Rogun hydroelectric stations under construction in the USSR were begun in 1974-1976. The geodetic studies in the region of the Nurek hydrostation call for evaluation of vertical and horizontal components of crustal movements possible as a result of filling the reservoir. Vertical movements of three bench marks located in the region of the Nurek dam on the downstream side show that the region of the dam is subsiding at a rate of 3.6-8.4 mm/yr. Vertical movements of an oscillatory character can be seen against the background of general subsidence of the earth's surface at the sites of the bench marks correlating to the change in volume of water in the reservoir and relative change in heights of the marks: with an increase of water volume the heights of the bench marks decrease and, conversely, a relative increase of the heights of the leveling marks corresponds to a decrease of water. Vertical movements in the region of the Rogun hydro development were studied along two repeated leveling routes laid out in the southern part of the reservoir. The rate of horizontal movements of geodetic points measured in 1949-1950, 1968, and 1971 in local stretches is within 9-17 mm/yr. The results obtained, although they are of a preliminary character, agree with geological and tectonic concepts. (Fish-PTT)
W91-05311

REFINEMENT OF THE ENGINEERING-GEOLOGICAL CONDITIONS OF THE FOUNDATION OF THE KHUDONI ARCH DAM.
A. I. Savich, V. K. Razumov, G. R. Khositashvili, A. M. Pershutkina, and T. L. Tetradze.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 122-130, 1990. 5 fig, 2 tab, 6 ref.

Descriptors: *USSR, *Hydraulic engineering, *Engineering geology, *Hydroelectric plants, *Dam foundations, Foundation rocks, Rock properties, Geological surveys, Geophysical surveys, Geologic fractures, Rock excavation, *Arch dams, Seismic exploration, Stress analysis, Elastic properties, Load testing.

The Khudon hydroelectric station is located in the U.S.S.R. on the Inguri River within an anticline of a large fold system. Detailed engineering-geological, geomechanical, and geophysical investigations were conducted at the site during the design stage, revealing a number of characteristics of the rock mass requiring design corrections. On the left wall of the canyon, a nonactive tectonic fault is developed parallel to the bedding. Geostructural analysis was made of the rock mass joint systems developed in the region; however, during excavation for the arch dam, the discovery of large fractures on the left bank was unexpected. Seismic data were analyzed to compare the rock properties of the undisturbed mass and the fault zone. The change in wave velocity with depth for rocks of the undisturbed mass occurred more rapidly than for rocks of the fault zone, due to different levels of stress acting on the rocks. Graphical analysis indicates that excavation of the foundation pit caused a considerable decrease of the elastic characteristics of the rock mass, and the rocks composing the fault zone are characterized by lower elastic indices only in the uppermost part of the section. The stress level of the fault zone rocks in the area of surface unloading is approximately 2 times lower than in the surrounding mass. On the basis of the original calculations of the foundation strength of the arch dam in the fault zone, without considering the natural stress state of the rocks, the design called for sealing the zone with concrete. However, the recent surveys indicate that the high level of natural stresses in the rocks of the left-bank abutment causes considerable unloading of the mass in the excavation zone, causing a sharp decrease of the indices of the physical, mechanical, and seepage properties of the rocks in selvages of

the zone. Therefore, underground sealing was rejected in favor of simple stabilization treatment of the upper 5-m 'decompressed' part of this zone. (Fish-PTT)
W91-05313

HYDROGEOTHERMAL THEORY OF EARTHQUAKES--BASIS OF PREDICTION, WARNING SYSTEMS, AND COUNTERACTIONS.
V. S. Panfilov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 2, p 142-148, 1990. 1 fig, 6 tab, 4 ref.

Descriptors: *USSR, Hydraulic engineering, *Geohydrology, *Earthquakes, *Geothermal water, Earthquake engineering, *Seismology, Geologic fractures, Free water, Thermal water, Steam, Earth pressure, Thermal energy, Heat flow, Elastic properties, Mathematical equations, Sulfur, *Warning systems, Water pressure, Water temperature.

A 'hydrogeothermal theory of the occurrence of earthquakes' has been previously developed from a generalization of the available data on phenomena of technogenic seismicity, calculations, and physical modeling. The presence of faults, fractures, and voids in the crust containing water in a free gravitational (not capillary) state is a necessary condition for the occurrence of earthquakes. An unstable thermohydraulic system is created in the fault due to heating of the lower part, with ejection of a steam-water mixture into the upper part of the fault which removes the pressure in the lower part, which is the main source of energy of the earthquake trigger. It is necessary to estimate the energy of the passing heat flow to determine what amount of this flow can be stored and the efficiency of this mechanism. Estimations of the possible range of this energy completely correspond to the data of on-site observations of the intensity and frequency of earthquakes. The mechanism of ejection due to phase transformations can be described by a system of three or four differential equations relating the fault pressures, water levels and volumes, steam, and elastic strains of the masses considering only the internal heat of the system. The efficiency of the ejection system will not substantially change as a function of pressure and temperature, but can be determined more exactly by solving a system of equations and by experiments. At great depths sulfur can play the same role as water in crustal earthquakes. Earthquake warning systems should be based on a system of recording water pressures and temperature in the fault zone at various depths to compare them with the water parameters along the phase transformation line; the counteraction system should be based on elimination of the possibility of the formation of unstable steam-water systems in faults. (Fish-PTT)
W91-05316

CHARACTERIZING IN SITU STRESS DOMAINS AT THE AECL UNDERGROUND RESEARCH LABORATORY.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
C. D. Martin.
Canadian Geotechnical Journal CGJOAH, Vol. 27, No. 5, p 631-646, October 1990. 22 fig, 1 tab, 27 ref, append.

Descriptors: *Waste disposal, *Radioactive waste disposal, *Structural geology, *Rock mechanics, *Stress analysis, *Geologic fractures, *Hydraulic fracturing, *Rock excavation, Anisotropy, Granites, Cores, Manitoba, Canada, *Underground waste disposal.

Atomic Energy of Canada Limited (AECL) is conducting geomechanical research at its Underground Research Laboratory (URL) in southeastern Manitoba, Canada, as part of its research program to assess the feasibility of nuclear fuel waste disposal deep in a plutonic rock mass. The URL access shaft was excavated from the surface to about the 185-m depth in jointed pink granite. Below this depth, to the 443-m depth, the shaft was excavated in massive gray granite. The gray granite is essentially unjointed, except for a major low-dipping thrust fault and associated minor splays. Overcoring, hydraulic fracturing, convergence measurements, microseismic monitoring, and observations of shaft-wall failure and core discing, indicate that unusually high in situ stresses can be associated with large volumes of massive, unjointed granite at fairly shallow depths. The database of in situ stress measurements collected at the URL indicates that major geological features, such as thrust faults, can act as boundaries for in situ stress domains and that both the magnitude and direction of the in situ stress state can change when these geological features are traversed. Stress relief in the form of microcracking can occur and result in anisotropy and nonlinear response. The method for interpreting the stress magnitudes from subhorizontal hydraulic fractures needs further investigation. The interpretation of in situ stresses requires a thorough understanding of the limitations of the methods used to obtain the stresses and a good geological model. (Fish-PTT)
W91-05362

TURBULENT STRUCTURE IN COMPOUND OPEN-CHANNEL FLOWS.
Nagoya Inst. of Tech. (Japan). Dept. of Civil Engineering.
A. Tominaga, and I. Nezu.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 117, No. 1, p 21-41, January 1991. 15 fig, 1 tab, 29 ref.

Descriptors: *Channel morphology, *Fluid mechanics, *Open channels, *Roughness coefficient, *Turbulence, *Turbulent flow, Channel flow, Flood plains, Flow velocity, Hydraulic engineering, Reynolds number, Shear stress.

An investigation of three-dimensional (3-D) turbulent structure, including turbulence-driven secondary currents in compound open-channel flows, is important in hydraulic and river engineering, as well as in fluid mechanics. Accurate measurements in fully developed compound open channel flows are conducted by mean of a fiber-optic laser Doppler anemometer 3-D measurement system. The characteristics of compound open-channel flows are recognized in the junction region between the main channel and flood plain, whereas the characteristics of rectangular open-channel flows are observed in a region near the sidewall of the main channel. Strong, inclined secondary currents, which are associated with a pair of longitudinal vortices, are generated in the junction region between the main channel and the flood plain. The primary mean velocity field is directly influenced by these secondary currents. Three-dimensional structures of Reynolds stresses and turbulence intensities were revealed in compound open-channel flows. The distributions of Reynolds stresses in the x-y and x-z planes are affected by the strong momentum exchange between the main channel and the floodplain. When the flood plain bed was rough, the structure of secondary currents was almost the same as that for a smooth bed. (Author's abstract)
W91-05420

8F. Concrete

LOW-CLINKER CEMENT FOR HYDRAULIC STRUCTURES.
E. I. Allilueva, and L. M. Deryugin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 13-16, 1990. 2 fig, 2 tab, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 16-18, January, 1990.

Descriptors: *Concrete construction, *Concretes, *Dam construction, *Hydraulic structures, *Low-clinker cement, *Portland cements, Dams, Hydration, Hydroelectric power plants, Roller-compacted concretes, Soviet Union.

Portland blast-furnace cement (PBFC) with a slag content of up to 50% is widely used in the Soviet Union for construction of hydraulic structures. Practically all hydro developments in Siberia, the Far North, and the Far East have been constructed using PBFC of grade 300 produced according to technical specifications TU 21-21-4-82. A change in the conditions and technology of constructing dams requires broadening of the range of PBFC. In the construction of the Katun hydroelectric station, low-cement, roller-compacted concretes with a strength of 20 MPa at a design age of 180 days and impermeability of 6-8 was used. For this order, a low-clinker cement with a content of 70-80% blast furnace slag, 15-25% clinker, and up to 5% gypsum was developed. At 28 days of normal hardening, the cement corresponds to grade 200 and has an activity margin of 1 to 7 MPa. The low-clinker cement has slower start and end of setting than that of PBFC according to TU 21-21-4-82, by about 1 hr. It is considerably behind PBFC in terms of hydration. By changing the content of the low-clinker cement in concrete, it was possible to obtain a broad range of concretes with an 8-mo strength of 15-30 MPa. Concretes with grades up to 200-250 were reliably obtained with average cement contents. Due to the lower heat of hydration of low-concrete cement and the decrease in heat liberation of concretes on its base, it is possible to increase the dimensions of blocks in plans and to considerably reduce expenditures on heat insulation and cooling the blocks of structures. (Rochester-PTT)
W91-05079

SELECTION OF THE COMPOSITION OF ROLLER-COMPACTED CONCRETES.
R. S. Tilles, F. E. Glebova, and N. A. Khokhlova.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 17-21, 1990. 5 fig, 1 tab, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 18-21, January, 1990.

Descriptors: *Concrete construction, *Concretes, *Roller-compacted concretes, Cements, Dam construction, Design criteria, Materials engineering, Plasticizers, Soviet Union.

There are three different concepts for the design and construction of rollcrete dams. Regardless of the required concrete grade, the main consideration when selecting and designing the proportions of the concrete mix being compacted by rollers is an acceptable particle size distribution that provides the required mechanical properties with a minimum of binding materials. A method of selecting the composition of rollcretes has been proposed based on generalization and analysis of foreign and Soviet experience. With maximum size of coarse aggregate in the range 120-150 mm, the content in volume % can be 55-60, whereas at a maximum aggregate size of 10 mm, the content is 40-45 volume %. The size of the coarse aggregate should not be less than 1/3 the height of the layer being compacted by the vibrating roller. Relationships have been determined for the numerous other relationships important to final concrete quality, such as dependence of strength on cement content, the dependence of concrete strength on density, and the relation between density and paste/mortar ratio. Based on these relationships, procedures have been developed for mixing content of the required stiffness and ultimate strength, and for ensuring that the concrete is workable during the rolling process. Plasticizing additives must be used. (Rochester-PTT)
W91-05080

USE OF PRECAST REINFORCED-CONCRETE BEAMS IN THE FLOORS OF THE DRAFT TUBES OF THE CHEBOKSARY HYDROELECTRIC STATION.
E. A. Bilev, and A. V. Kuzovkin.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 21-25, 1990. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 21-23, January, 1990.

Descriptors: *Concrete construction, *Hydraulic structures, *Hydroelectric plants, *Precast concrete, *Reinforced concrete, *Soviet Union, Cheboksary hydroelectric station, Dam construction, Economic analysis, Structural engineering.

Precast reinforced concrete members were used to a large extent in the construction of the hydraulic structures of the Cheboksary hydroelectric station (Soviet Union). One of the examples of the effec-

tive use of precast reinforced concrete members in structures at the Cheboksary hydroelectric station is the construction of the floors of the diffuser of the draft tubes. The floor span is 12 m and thickness of the floor varies from 4.5 to 2 m. A tower crane was necessary for installing the 5-ton B-1-5 diffuser floor beams. The reserve bearing capacity of the design beams was realized by using the entire design height of the beams with the condition of working under 'oblique bending.' Under oblique bending, beams of an angle profile supported by their base on an inclined plane and oriented 'toe' downslope work more effectively, as a full section. Design studies confirmed that the lightweight PB-1,2 beams had equal strength to the B-1-5 design. The following economic benefits were obtained from using the type PB beams in sections 3-9 of the diffuser floor: (1) a reduction of the scarce time of the BK-1000 cranes by 70-75% by using the more available and maneuverable KBGS-450 crane; (2) a reduction (up to 0.6 ton) of the consumption of metal of the reinforcement cages of the PB beams by the more efficient functioning of the beams under oblique bending and more rational use of reinforcing bars of variable section in accordance with the momentum diagram; and (3) reduction of the volume of precast reinforced concrete by 4 cu m/beam, which reduced the weight per beam by 10 tons. The use of creative engineering at this site helped to bring the project to completion on time and with minimum expenditure. (Rochester-PTT)
W91-05081

CONCRETE-FACED ROCKFILL DAM.
Cooke (J. Barry), Inc., San Rafael, CA.
For primary bibliographic entry see Field 8A.
W91-05116

DESIGN AND CONSTRUCTION OF THE SEGREDO CONCRETE-FACED ROCKFILL DAM.
Companhia Paranaense de Engeria, Curitiba (Brazil).
For primary bibliographic entry see Field 8A.
W91-05117

ADVANCES IN FACE SLAB CONSTRUCTION TECHNIQUES FOR CFRDS.
Tasmania Hydro-Electric Commission, Hobart (Australia). Engineering Div.
A. Beach, R. Gill, and P. Van Emmerick.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 19-23, January 1991. 4 fig, 2 ref.

Descriptors: *Australia, *Concretes, *Dam construction, *Rockfill dams, Hydroelectric plants, Management planning, Newton Dam, Tasmania, White Spur Dam.

The Hydro-Electric Commission of Tasmania (Australia) was a pioneer in the early development of face slab construction techniques for concrete-faced rockfill dams (CFRDs). A revised approach has been adopted recently to minimize overall construction duration and labor requirements. The objectives of the new approach are as follows: (1) minimize the delay between completion of the rockfill and commencement of concrete placement; (2) omit starter bays; (3) minimize the delay between bay pours to achieve almost continuous concrete placement; (4) ensure that the slipform could accommodate variable bay widths; (5) minimize uplift of the slipform; (6) minimize the labor requirement overall, both in person-hours and skill of labor; and provide a uniform workload to maximize the efficiency of the work force. The new methods and equipment to meet these objectives have been used successfully on two small dams at the HEC's Anthony Power Development, the 44 m-high White Spur dam and 37 m-high Newton dam. At Newton the overall labor reduction was 35% compared to HEC's original approach for CFRDs. The ultimate productivity that can be achieved for face slab construction depends not only on the methods and equipment, but on factors such as site topography, climate, industrial relations, and degree of multi-skilling in the work force. (Rochester-PTT)
W91-05118

COLOMBIAN EXPERIENCE WITH CONCRETE FACE ROCKFILL DAMS.
Ingetec S.A., Bogota (Colombia).
For primary bibliographic entry see Field 8A.
W91-05119

PRELIMINARY INVESTIGATION OF CEMENTITIOUS MATERIALS FOR OLMSTED LOCK AND DAM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
T. S. Poole, M. C. Sykes, and S. D. Griffin.
Available from the National Technical Information Service, Springfield, VA 22161. Miscellaneous Paper SL-90-3, October 1990. Final Report. 31p, 8 fig, 7 tab, 4 ref.

Descriptors: *Cements, *Materials testing, *Olmsted Lock and Dam, *Construction materials, Fly ash, Portland cement, Strength, *Concretes, Dams.

The effect of 4 fly ashes on strength development and heat-of-hydration characteristics of portland cement-fly ash mixtures was investigated. These comprise three class F and one Class C fly ash. Mixtures containing Class C fly ash gained strength more rapidly than mixtures containing Class F fly ash. At 2 days, heat of hydration was reduced by all fly ashes, but the Class C fly ash contributed substantial heat at later ages; exceeding pure portland cement in some mixtures. Class C fly ashes are reputed to contribute more to early strength gain than equivalent replacements of Class F fly ashes. In this investigation, two Class C fly ashes were evaluated for use at Red River Lock and Dam 3. Mixtures containing these fly ashes at 30% replacement for portland cement exhibited about 70% of control strength at 7 days compared with the 60% of control exhibited by Class C ash in this study. At 28 days the Red River ashes had gained >90% of control, while the ash used in this study had gained to 82% of control. This difference may not be due to the differences among fly ash sources since different portland cements were used. (Lantz-PTT)
W91-05270

IN SITU REPAIR OF DETERIORATED CONCRETE IN HYDRAULIC STRUCTURES: EPOXY INJECTION REPAIR OF A BRIDGE PIER.
Brookhaven National Lab., Upton, NY. Process Sciences Div.
For primary bibliographic entry see Field 8G.
W91-05274

8G. Materials

EFFECT OF DILATANCY OF ROCKS ON RESISTANCE TO SHEARING LOADS.
For primary bibliographic entry see Field 8E.
W91-05077

CONCEPT OF SAFETY EVALUATION OF THE ARCH DAM OF THE INGURI HYDROELECTRIC STATION.
For primary bibliographic entry see Field 8A.
W91-05082

WAYS TO INCREASE THE SERVICE LIFE OF METAL MEMBERS OF HYDRAULIC STRUCTURES.
B. Y. Aivazov, M. S. Trifel, and G. M. Akhmedov.
Hydrotechnical Construction HYCOAR, Vol. 24, No. 1, p 41-43, 1990. 2 fig, 1 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 1, pp. 34-36, January, 1990.

Descriptors: *Corrosion, *Corrosion control, *Hydraulic structures, *Metals, Aluminum, Anodes, Cathodes, Coatings, Oxides, Tensile strength, Zinc.

For numerous reasons, organic coatings are unsuitable for protecting large metal members of hydraulic structures from corrosion. The presence of paint on a metal surface leads to the occurrence of anodic potentials, resulting in the formation of water-filled gas bubbles, which encourage corrosion of the metal at places where the paint is damaged. A metallic coating was developed by applying molten aluminum on a zinc sublayer. The aluminum coatings exceed by tens of times the corrosion resistance of nonferrous metal members. The electrode potentials of the aluminum coating are close to the potentials of the nonferrous metal, which in the overwhelming number of cases precludes the formation of anodes at places of coating damage. The effect of a mechanical load in a corrosive environment was tested using the aluminum alloy ATsM. Specimens were subjected to cathode currents of densities of 0.01, 0.02, 0.06, 0.1, and 0.2 A/sq m. The test was conducted for 40 days on loaded specimens with a stabilized current density. The specimens remained uncorroded. Residual strength tests conducted following the initial stress test showed that polarization did not decrease the strength of the alloy, but increased the strength to a maximum of 1.78 times that of the unpolarized specimens. However, at current densities higher than 0.02 A/sq m, tensile strength decreased. Weakening of the specimen as a result of cathodic destruction of the oxide film by the cathodic alkaline products also occurred. The increase in corrosion rate of aluminum at current densities greater than 0.02-0.03 A/sq m indicates that cathodic polarization should be used with extreme caution for members with aluminum coatings in a corrosive environment. There is only a slight decrease of the corrosion rate at the maximum effectiveness of cathodic protection. The increase of strength of the polarized aluminum, even with maximum preservation of strength upon polarization, is 3-4% lower than the initial strength of the unpolarized and unloaded structures. (Rochester-PTT)
W91-05085

PIEZOELECTRIC QUARTZ CRYSTAL WATER LEVEL MEASUREMENT.
Rittmeyer A.G., Zug (Switzerland).
H. P. Vaterlaus.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 36-38, January 1991. 3 fig, 6 ref.

Descriptors: *Instrumentation, *Measuring instruments, *Quartz sensors, *Water level, *Water pressure sensors, Design criteria, Hydraulic engineering.

In the management of water and energy resources, there is an increasing demand for 'intelligent' instrumentation. Paralleling this development, there has been a continual use increase in the demands made on the sensors in terms of accuracy, long-term stability, and ease of operation. Quartz technology, in conjunction with the microcomputer-controlled computation unit, offers an alternative and opens up new perspectives for accurate and level measurement, both in the laboratory and under more difficult environmental conditions. Quartz resonators consist of crystalline quartz (SiO_2). Under the simultaneous influences of an electric field (oscillator) and mechanical deformation (force, pressure), the internal energy of a piezoelectric quartz crystal is altered, resulting in a change in the quartz resonance frequency. By combining bellows of different dimensions, and varying the geometry of the quartz resonator, it is possible to cover pressure measurements from 0-0.1 MPa or from 0-3.5 MPa. The W1Q measuring system offers an innovative solution to the problem of obtaining high-precision water level readings. The instrument can be used to measure hydrostatic pressure by direct contact with the water (sensor on upstream face of dam below the water line) or it can be used to measure water level by pneumatic pressure measurement, where a tube forces air into the reservoir water and the pressure in the air column is measured and converted to a depth measurement. (Rochester-PTT)
W91-05120

DIFFERENTIAL PRESSURE TILTMETER FOR LARGE-SCALE GROUND MONITORING.
Meier (Edi) and Partner, Winterthur (Switzerland).

E. Meier.
International Water Power and Dam Construction IWPCDM, Vol. 43, No. 1, p 38-40, January 1991. 6 fig.

Descriptors: *Dam stability, *Earthquakes, *Instrumentation, *Measuring instruments, *Tiltmeters, Earth tides, Inclinometers.

Tilt measurement until recently employed high-resolution inclinometers of short base length. These inclinometers were introduced into boreholes. However, the results of these measurements were not very successful. A new system has been developed that permits enlarging the measurement base to 500 m with the result that local tilt effects are eliminated. Tidal effects on the earth provide the resolution basis for this new tiltmeter. The new instrument works on the principle of the differential pressure of two liquid columns causing a membrane to bend. This bending effect is converted into an electrical signal, which is recorded and interpreted by a computer. The instrument has a working range of 10 cm of elevation difference. The zero-line and linearity of the range can be controlled at any time by remote operation. Earthquakes, landslides, and nuclear explosions cause surface waves that are propagated all around the earth and registered by the tiltmeter. Such surface waves can be verified by comparison with seismographic records from any earthquake station. The new tiltmeter was installed at the Albigna dam at Bergell Valley, near Vicosoprano, Canton Grisons, Switzerland. The dam stands on a prominent rock barrier; the granite rock barrier tends to deform considerably during reservoir filling. Measurements of the tilt changes at the dam base in the period 1 November 1989 to 10 January 1990 showed that the upstream heel of the dam was sinking in relation to the downstream toe, almost continuously. Twice daily changes in tilt were observed in the reservoir foundation that were associated with earth tides caused by the moon and the sun. In addition, the whole rock foundation moves during impounding and drawing down of the reservoir. (Rochester-PTT)
W91-05121

PROPERTIES AND USE OF FLY ASHES FOR EMBANKMENTS.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
J. P. Martin, R. A. Collins, J. S. Browning, and F. J. Biehl.
Journal of Energy Engineering (ASCE) JLEED9, Vol. 116, No. 2, p 71-86, August 1990. 7 fig, 4 tab, 14 ref.

Descriptors: *Earthworks, *Embankments, *Fly ash, *Waste disposal, Cost analysis, Delaware, Economic aspects, Highways, New Jersey, Pennsylvania, Structural engineering, Thermal powerplants.

Coal-fired power plants produce millions of tons of fly ash annually, but only a fraction is productively employed. The geotechnical properties of ashes from coal-burning utilities in Pennsylvania, Delaware, and New Jersey were investigated for use in a highway embankment for I495 near Wilmington, Delaware. Mechanical and environmental data were obtained from laboratory tests, construction observations, and postconstruction exploration. Results were compared to published results for ashes from other sources. Geotechnical properties of light-weight fly ashes from the Delaware Valley can be readily quantified by customary methods and the mass behavior of a compacted embankment can be predicted. Published studies indicate that fly ash can be rapidly compacted with methods similar to those used for granular soils and construction with fly ash is less sensitive to compaction-moisture content than the fine-grained soils commonly used as structural fill. Overall performance equals or exceeds that of similarly graded natural borrow materials. Postconstruction exploration of embankments indicates high resistance to penetration. In this study, the materials were relatively innocuous environmentally. Although the performance of fly ash is underpredicted by the empirical correlations and assumptions traditionally used in standard earthwork practice, the availability of fly ash at little or no cost may make it competitive with other materials. (Rochester-PTT)
W91-05122

RELIABILITY MODEL FOR SOIL LINER: POSTCONSTRUCTION.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
I. Bogardi, W. E. Kelly, and A. Bardossy.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 10, p 1502-1520, October 1990. 11 fig, 5 tab, 33 ref.

Descriptors: *Landfills, *Liners, *Permeability, *Testing procedures, Composite flexible membrane liners, Geostatistics, Leakage, Prediction, Reliability.

The guidance required for composite flexible membrane liner (CFML) systems prescribes construction of a test fill for a compacted soil liner using the same material, procedures, and equipment that will be used on the full-scale facility. Test-fill results are helpful, but the extrapolation to the full-scale liner from these results is far from certain. A methodology was developed for predicting post-construction reliability of full-scale liners given a set of direct and indirect (compaction moisture content and dry density) permeability measurements from a test fill. The permeability is considered as a spatially-correlated, lognormally-distributed random variable. Six systems-reliability measures are defined to characterize a soil liner represented by a system of blocks and lifts. The reliability measures are weakest link, averaging, and parallel systems of blocks and lifts. Geostatistics is used to transfer test-fill information to full-scale liner permeability/reliability estimates. A relationship was developed for the number of permeability measurements necessary to monitor construction of the full-scale liner, the target average permeability, the specified reliability limit. The methodology is illustrated with a numerical example. Direct permeability measurements and surrogate tests commonly performed during soil-liner construction can be combined. Reliability bounds, based on effective hydraulic permeability, can be obtained by considering various simple averaging schemes over a multilift soil liner. (Rochester-PTT)
W91-05126

PRELIMINARY INVESTIGATION OF CEMENTITIOUS MATERIALS FOR OLMSTED LOCK AND DAM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
For primary bibliographic entry see Field 8F.
W91-05270

IN SITU REPAIR OF DETERIORATED CONCRETE IN HYDRAULIC STRUCTURES: EPOXY INJECTION REPAIR OF A BRIDGE PIER.
Brookhaven National Lab., Upton, NY. Process Sciences Div.
R. P. Webster, L. E. Kukacka, and D. Elling.
Available from the National Technical Information Service, Springfield, VA 22161as DE87004607. Price codes: A03 in paper copy, A01 in microfiche. Technical Report REMR-CS-30, September 1990. Final Report. 109p, 31 fig, 7 tab, 5 ref, 4 append.

Descriptors: *In situ repair, *Maintenance, *Hydraulic structures, *Epoxy, *Piers, *Concretes, Concrete construction, Field tests, Mississippi River, Case studies.

A survey by the US Army Corp of Engineers showed that the three most common problems encountered in the Corp's civil works concrete hydraulic structures were: (a) cracking, (b) seepage, and (c) spalling. These three problems accounted for 77% of the 10,096 deficiencies identified during a review of inspection reports. Concrete cracking was observed most often, accounting for 38% of the deficiencies. In situ repairs seem suited to repairing deterioration caused by cracking and spalling, although they may not be readily applicable to seepage problems. Presented are the results of the fourth and final phase of a research program directed toward identifying in situ repair procedures to be utilized in the rehabilitation of cracked concrete hydraulic structures. Emphasis of the laboratory and field research performed in Phase 4 was directed toward the optimization of equipment and materials to be used with pressure repair injection techniques. The repair procedure is demonstrated in a field test performed at Lock and Dam 13 on the Mississippi River at Fulton, IL. Results of hydrostatic pressure tests showed that molded injection ports mounted within a drilled port hole can withstand pressures of 200 to 275 psig before leaks begin to develop around the perimeter of the injection ports. Surface mounted ports withstand pressures between 50 and 150 psig, depending upon the type of port. (Lantz-PTT)
W91-05274

PIPING AND EROSION TESTS AT CONNER RUN DAM.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 8D.
W91-05870

RAPID WATER CONTENT BY COMPUTER-CONTROLLED MICROWAVE DRYING.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
P. A. Gilbert.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 117, No. 1, p 118-138, 1991. 7 fig, 2 tab, 17 ref.

Descriptors: *Compaction, *Drying, *Field tests, *Hydraulic engineering, *Microwaves, *Soil analysis, *Soil water, Clays, Data acquisition, Earth dams, Earthworks, Gypsum, Heating, Soil compaction, Soil properties.

Equipment for determining water content rapidly, accurately, and reliably is required to properly monitor the compaction of earth fills. A microwave drying system has been developed to determine water content reliably and accurately in real time. The design of the system is based on continuously monitoring the weight change of a soil specimen subjected to automated microwave radiation. Analysis of data acquired during initial testing and two subsequent field studies show that agreement between control and microwave tests for a wide variety of soils is usually less than half a percentage point and often substantially less for properly-sized specimens. Specimens used with this equipment should have an initial mass between 100 and 200 g. Water content determination in the microwave oven appears to be unaffected by particle size, i.e., the size of a chunk or clump of clay; however, 1-in (2.5 cm) sizes or less appear to be optimal. Containers used in the oven should be able to transmit microwaves. Some undisturbed low-permeability soils will explode upon exposure to microwave heating, and should be contained in capped vessels which allow for escape of vapor pressure. A microwave oven should not be used to dry soil without the provision of an empty oven load. Gypsum-rich soils are dehydrated by the microwave oven system and do not converge to the correct water content, and should not be analyzed by this method. (Fish-PTT)
W91-05871

8I. Fisheries Engineering

SPRING GROWING PERIOD AS A REGULATOR OF THE SIZE OF THE SMOLT RUN IN TROUT (SALMO TRUTTA).
Department of the Marine, Castleknock (Ireland). Fisheries Research Centre.
For primary bibliographic entry see Field 2H.
W91-05000

ESTIMATION OF FISH PRODUCTION AND POTENTIAL YIELD IN LAKE MANZALA, EGYPT.
Cairo Univ., Giza (Egypt). Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W91-05001

POTENTIAL EFFECTS OF GLOBAL WARMING ON NATIVE FISHES OF THE SOUTHERN GREAT PLAINS AND SOUTHWEST.
Oklahoma Univ., Kingston. Biological Station.
For primary bibliographic entry see Field 2B.
W91-05166

GLOBAL CLIMATE CHANGE: POLICY IMPLICATIONS FOR FISHERIES.
NSI Technology Services Corp., Corvallis, OR.
H. Gucinski, R. T. Lackey, and B. C. Spence.
Fisheries (Bethesda) FISHDN, Vol. 15, No. 6, p 33-38, November/December 1990. 1 tab, 42 ref.

Descriptors: *Resources management, *Research priorities, Primary productivity, Social aspects, *Climate change, *Policy making, *Fisheries, *Global warming, Species composition, Genetics, Fish populations, Spawning.

Several government agencies are evaluating policy options for addressing global climate change. These include planning for anticipated effects and developing mitigation options where feasible if climate does change as predicted. For fisheries resources, policy questions address effects on international, national, and regional scales. Climate change variables expected to affect inland and offshore fisheries include temperature rise, changes in the hydrologic cycle, alterations in nutrient fluxes, and reduction and relocation of spawning and nursery habitat. These variables will affect resources at all levels of biological organization, including the genetic, organism, population, and ecosystem levels. In this context, changes in primary productivity, species composition in the food web, migration, invasions, synchrony in biological cycles, shifts in utilization of niches, and problems of larvae entrainment in estuaries have been identified. Maintaining ecosystem robustness (i.e. high biodiversity) is another component of the problem. Action requires establishing priorities for information needs, determining appropriate temporal and spatial scales at which to model effects, and accounting for interactive changes in physical and biological cycles. A policy response can be derived when these results are integrated with social needs and human population constraints. (Author's abstract)
W91-05167

DOES HISTORY HAVE A FUTURE. FORECASTING CLIMATE CHANGE EFFECTS ON FISHERIES BY ANALOGY.
National Center for Atmospheric Research, Boulder, CO. Environmental and Societal Impacts Group.
For primary bibliographic entry see Field 2B.
W91-05168

OBSERVATIONAL AND MODEL STUDIES OF PHYSICAL PROCESSES AFFECTING BENTHIC LARVAL RECRUITMENT IN DELAWARE BAY.
Cook Coll., New Brunswick, NJ. Dept. of Marine and Coastal Sciences.
T. R. Jacobsen, J. D. Milutinovic, and J. R. Miller.
Journal of Geophysical Research (C) Oceans JGRCEY, Vol. 95, No. 11, p 20,331-20,345, November 15, 1990. 15 fig, 34 ref, append.

Descriptors: *Population dynamics, *Estuarine environment, *Oysters, Ecological distribution, *Model studies, *Larvae, *Delaware Bay, *Benthic fauna, Advection, Particle dispersion, Vertical migration, Mathematical models, Wind.

Physical processes are important in determining benthic recruitment success in estuarine ecosystems. Two field studies have been conducted with passive surface drifters to examine the large-scale advection and local dispersion in the region of the oyster seed beds in Delaware Bay. The two studies show that the wind is critical in determining the final location of the drifters and that axial fronts in the bay may play an important role in reducing cross-bay particle dispersion and may keep particles in the nearshore oyster beds. Simulations of particle trajectories from a three-dimensional numerical model of Delaware Bay were also analyzed to determine the sensitivity of particle trajectories to varying wind conditions and different assumptions about larval vertical migration. Understanding the three-dimensional dispersion and ultimate recruitment within an estuary is of critical importance to understanding the population dynamics of benthic ecosystems. (Author's abstract)
W91-05169

CONSERVATION STATUS OF THREATENED FISHES IN WARNER BASIN, OREGON.
Bureau of Land Management, Washington, DC. Wildlife and Fisheries Div.
For primary bibliographic entry see Field 6G.
W91-05203

ICHTHYOFAUNAL EVALUATION OF THE PEACE RIVER, FLORIDA.
Florida Game and Fresh Water Fish Commission, Lakeland, FL.
For primary bibliographic entry see Field 5C.
W91-05411

FISHERY-DEPENDENT BASED STUDY OF FISH SPECIES COMPOSITION AND ASSOCIATED CATCH RATES AROUND OIL AND GAS STRUCTURES OFF LOUISIANA.
Louisiana State Univ., Baton Rouge. Coastal Ecology and Fisheries Inst.
D. R. Stanley, and C. A. Wilson.
Fishery Bulletin FSYBAY, Vol. 88, No. 4, p 719-730, 1990. 4 fig, 7 tab, 25 ref.

Descriptors: *Fish harvesting, *Fish populations, *Fisheries, *Louisiana, *Offshore platforms, *Oil wells, *Species composition, Data acquisition, Field tests, Gas structures, Oil industry, Population density, Red snapper, Sea trout.

The impact of oil and gas development on fish populations off Louisiana is presumed significant but poorly understood. A study investigated the applicability of a logbook program in developing a long term database of species composition and relative abundance of fish associated with oil and gas structures. A pilot logbook program involving 120 private vessel owners and 25 charterboat operators was conducted between March, 1987 and December, 1988. Participants recorded date, fishing time, fishing method, number of anglers, and catch composition at each structure fished. Logbooks from a total of 55 private vessel owners and 10 charter boat operators were used in the analysis. Data collected included 15,780 angler hours of fishing effort and 61,227 fish caught over the study period. A total of 1719 trips were made to 589 different oil and gas structures with at least 46 different species of fish caught. Red snapper and spotted seatrout were the most commonly caught species and had the highest catch rates. Results differed from past logbook programs and creel surveys, possibly indicating a change in the community of fish associated with oil and gas structures. (Author's abstract)
W91-05460

TEMPORAL DISTRIBUTION OF ICHTHYOPLANKTON NEAR BEAUFORT INLET, NORTH CAROLINA.
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 2L.
W91-05593

EFFECTS OF ESTUARINE ENVIRONMENTAL CONDITIONS ON POPULATION DYNAMICS OF YOUNG-OF-THE-YEAR GULF MENHADEN.
Louisiana State Univ., Baton Rouge. Dept. of Marine Science.
For primary bibliographic entry see Field 2L.
W91-05595

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

HOUSEHOLD WATER QUALITY EDUCATION: THE COOPERATIVE EXTENSION SYSTEM ROLE.
Kansas State Univ., Manhattan. Cooperative Extension Service.
For primary bibliographic entry see Field 5F.
W91-05700

9C. Research Facilities

USEPA POLLUTION PREVENTION RESEARCH PROGRAM.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
For primary bibliographic entry see Field 5G.
W91-05669

CENTER FOR AQUIFER SCIENCE AND TECHNOLOGY (CAST).
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Environmental Engineering.
D. B. Aulenbach.
Northeastern Environmental Science NOESDE, Vol. 8, No. 2, p 100-105, 1989. 2 fig, 16 ref.

Descriptors: *Groundwater research, *Interdisciplinary studies, *Research facilities, *Research priorities, *Scientific personnel, *Technical societies, Aquifer characteristics, Environmental engineering, Laboratories, Site remediation, Soil contamination, Water pollution.

In July 1987 the program in Environmental Engineering and Environmental Sciences (EEES) was established at Rensselaer Polytechnic Institute. This program brings together faculty in Environmental Engineering, Chemistry, Biology, Geology, Civil Engineering, Chemical Engineering, Nuclear Engineering, Systems Engineering, and Operations Research and Statistics to address fundamental and applied aspects of environmental studies, including biotransformation, microbial ecology, and interfacial phenomena. This group is committed to considering the problems of hazardous and toxic wastes, one of the more pressing environmental problems in society today. In an effort to conduct research on the interrelationships of materials in the ground, the Center for Aquifer Science and Technology (CAST) was created, dedicated to developing a more complete understanding of the functioning of aquifers, both natural and stressed. The information gained from these studies will be vital to the exploration of methods for remediation of contaminated soils and groundwater. To facilitate these studies, a dedicated laboratory, the AquiSim Laboratory, is being created. In addition to typical small soil column experiments, this laboratory will contain large full-scale modules (AquiSim Modules) containing both natural and simulated soil profiles in which both unsaturated and saturated soil conditions can be simulated. The goals of the CAST research are to understand the interrelationships among geomedia and microbial and chemical activities in the vadose and saturated subsurface soil materials of the ground. Research products include baseline knowledge of the behavior of natural earth systems, and better technology for dealing with contaminated earth and groundwater. (Author's abstract)
W91-05795

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

GEOGRAPHIC INFORMATION SYSTEM DOCUMENTATION OF WATERSHED DATA FOR DIRECT/DELAYED RESPONSE PROJECT: SOUTHERN BLUE RIDGE PROVINCE DATABASE.
NSI Technology Services Corp., Corvallis, OR.
For primary bibliographic entry see Field 7C.
W91-05278

10F. Preparation Of Reviews

DYNAMICS AND CONTROL OF SUBSTRATE INHIBITION IN ACTIVATED SLUDGE.
Waterloo Univ. (Ontario). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W91-04937

COLIFORM REGROWTH IN DRINKING WATER: A REVIEW.
American Water Works Service Co., Inc., Belleville, IL. Belleville Lab.
For primary bibliographic entry see Field 5F.
W91-05023

CHRONIC TOXICITIES OF SURFACTANTS AND DETERGENT BUILDERS TO ALGAE: A REVIEW AND RISK ASSESSMENT.
Battelle, Columbus, OH. Environmental Biology and Assessment.
For primary bibliographic entry see Field 5C.
W91-05102

PESTICIDE RESIDUES IN FRESHWATER AND MARINE ZOOPLANKTON: A REVIEW.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5B.
W91-05113

USE OF LYSIMETERS TO ESTIMATE LEACHING OF PESTICIDES IN AGRICULTURAL SOILS.
Sveriges Lantbruksuniversitet, Uppsala. Div. of Water Management.
For primary bibliographic entry see Field 7B.
W91-05389

MEMBRANE SEPARATION PROCESSES FOR TREATMENT OF HAZARDOUS WASTE.
Cartwright Consulting Co., Minneapolis, MN.
For primary bibliographic entry see Field 5D.
W91-05689

PERFORMANCE AND APPLICATIONS OF GRANULAR ACTIVATED CARBON POINT-OF-USE SYSTEMS.
Amway Corp., Ada, MI. Research and Development Div.
For primary bibliographic entry see Field 5F.
W91-05706

SUBJECT INDEX

ACCRETION
Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

ACETATES
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester G .es and Methanogenesis from Acetate.
W91-04944 5D

ACID LAKES
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

ACID MINE DRAINAGE
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

ACID RAIN
Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

ACID RAIN EFFECTS
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

ACID STREAMS
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

ACIDIC LAKES
Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

ACIDIC SOILS
Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

ACIDIC WATER
Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

ACIDIFICATION
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

ACIDITY
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

ACONCAGUA RIVER BASIN
Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

ACTIVATED ALUMINA
Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

ACTIVATED CARBON
Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

ACTIVATED SLUDGE
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

ACTIVATED SLUDGE PROCESS
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

ACUTE TOXICITY
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

ADMINISTRATIVE AGENCIES
Improving Strategies for Chemical Spills.
W91-05035 5G

Brief Review of Water Rights in New Hampshire.
W91-05213 6E

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

USEPA Pollution Prevention Research Program.
W91-05669 5G

DHS Waste Reduction Program.
W91-05670 5G

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

ADMINISTRATIVE REGULATIONS
Point-of-Use/Entry Treatment of Drinking Water.
W91-05694 5F

ADSORBENTS
Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

ADSORPTION
Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

Sewage Clarification with Magnetite Particles.
W91-05780 5D

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

ADSORPTION KINETICS
Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

ADVANCED WASTEWATER TREATMENT
Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

ADVECTION
Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

AERATED LAGOONS
Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

AERATION
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

AERATORS
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

AEROBIC CONDITIONS
Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

AEROBIC DIGESTION
Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

AEROBIC TREATMENT
Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

AEROSOLS
Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

AFRICA
Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

AGGREGATES
Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

AGRICULTURAL CHEMICALS
Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

AGRICULTURAL HYDROLOGY
Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

AGRICULTURAL PRACTICES
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

AGRICULTURAL RUNOFF
Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

AGRICULTURAL WATER
Rice and Furrow Irrigation Management.
W91-05159 3F

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

AGRICULTURAL WATERSHEDS
Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

AGRICULTURE
Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

AGRONOMY
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

AIR POLLUTION
Environmental Health.
W91-05051 6G

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

AIR POLLUTION CONTROL
Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

AIR POLLUTION EFFECTS
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

AIR POLLUTION SOURCES
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

AIR STRIPPING
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

AIR TEMPERATURE
Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

AIR-WATER INTERFACES
Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

AIRCRAFT
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

ALASKA
Wilderness Water Purification.
W91-05803 5F

Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

ALBERTA
Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

ALDER TREES
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

ALFALFA
Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

ALGAE
Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

ALGAE HARVESTING
Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

ALGAL BLOOMS
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

ALGAL CONTROL
Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

ALGAL GROWTH
Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

ALGAL TOXINS
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

ALGICIDES
Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

ALGORITHMS
Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

ALKALINE WATER
Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

ALKALINITY
Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

ALLUVIAL AQUIFERS
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

ALUM
Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

ALUMINUM
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

ALUMINUM HYDROXIDE
Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

AMERICIUM
Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

AMERICIUM RADIOISOTOPES
Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

AMINES
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

AMINO ACIDS
Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

AMMONIA
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

AMMONIA REMOVAL
Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

AMMONIUM
Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

ANAEROBIC BACTERIA
Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

ANAEROBIC DIGESTION
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

ANAEROBIC DIGESTION

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

ANAEROBIC FILTERS

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

ANALYSIS OF VARIANCE

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

ANALYTICAL METHODS

Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

ANALYTICAL TECHNIQUES

Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

ANCHORS

Anchoring a Dam.
W91-05069 8A

ANIMAL PHYSIOLOGY

Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

ANION EXCHANGE

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

ANNUAL PRECIPITATION

Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

ANNUAL RUNOFF

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

ANOXIC CONDITIONS

Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

ANTARCTIC

Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

ANTECEDENT MOISTURE

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

ANTIFOULANTS

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

AOMORI
239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

AQMAN MODELS
Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

AQUACULTURE
Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

AQUATIC ANIMALS
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

AQUATIC BACTERIA
Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

AQUATIC HABITATS
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

AQUATIC INSECTS
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

AQUATIC PLANTS
Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Plants Protect Water Bodies.
W91-05087 5G

Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

AQUATIC WEEDS
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

AQUIFER CHARACTERISTICS
Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

AQUIFER MANAGEMENT
New State Geologic Map for Mississippi: A Tool for Updating Nomenclature and Definitions of the State's Aquifers and Aquitards.
W91-05158 7C

AQUIFER SYSTEMS
Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

AQUIFER TESTING
Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

AQUIFERS
Miscible Displacement with Density and Viscosity Contrasts. Estimation of Displacement Parameters and Stability in Mechanical Dispersion Regime (Deplacement Miscible Avec Contrastes de Densite et de Viscosite en Milieu Poreux. Identification des Parametres de Deplacement et Stabilite en Regime de Dispersion Mecanique).
W91-05435 5B

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Soil Controls on Recharge to Aquifers.
W91-05469 2F

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

AQUITARDS
Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

ARCH DAMS
Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

ARCTIC ZONE
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

ARID CLIMATES
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

ARID CLIMATES

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

ARID LANDS
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

ARID REGIONS
Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

ARIZONA
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

ARMA MODELS
ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

AROMATIC COMPOUNDS
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

ARSENIC
Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

ARTIFICIAL LAKES
Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

ARTIFICIAL RECHARGE
Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

ARTIFICIAL WATERCOURSES
Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

ARTIFICIAL WETLANDS
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

ASBESTOS
Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

ASH
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

ASH DISPOSAL
Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

ATLANTIC OCEAN
Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

ATMOSPHERIC CHEMISTRY
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

ATMOSPHERIC CIRCULATION
Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

ATMOSPHERIC PHYSICS
Updating the Smith-Feddes Model.
W91-05277 2B

ATMOSPHERIC WATER
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

ATOLLS
Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

ATOMIC ABSORPTION SPECTROPHOTOMETRY
Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

ATRAZINE
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

ATTITUDES
Public Attitude Towards Water and Water Reuse.
W91-05546 6B

AUSTRALIA
Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

AUTOMATION
ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Continuous Water Quality Monitoring.
W91-05287 5G

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

Computerised Instrumentation and Control Systems.
W91-05293 7B

Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

AVALANCHES
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

BACTERIA
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

BACTERIAL ANALYSIS
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

BACTERIAL GROWTH
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

BACTERIAL PHYSIOLOGY
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

BACTERIAL PRODUCTIVITY
Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

BACTERIOPHAGE
Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

BAHAMAS
Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

BAHRAIN
Chemical Analysis of Irrigation Waters in Bahrain.
W91-05545 3F

BALTIC SEA
Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

BANGLADESH
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

BANK CLEARING
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

BANK EROSION
Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

BARBADOS
Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

BARIUM
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

BARRIER ISLANDS
Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

BARRIERS
Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

BASE FLOW
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

BASELINE STUDIES
Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

BEACH EROSION
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

BED LOAD
Bed Features in Nonuniform Sediments.
W91-05426 2E

BENTHIC ENVIRONMENT
Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

BENTHIC FAUNA
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

BENTHIC SAMPLING
Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

BENTHOS
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

BENZ (A)PYRENE
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

BENZENE
Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

BERMUDA
Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

BERMUDAGRASS
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

BIG PINE KEY
Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

BINGHAM PLASTICS
Stability of Free Surface Sediment Flow.
W91-05170 2J

BIOACCUMULATION
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

BIOASSAY
Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Mollusciciding.
W91-05468 7B

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

BIOCHEMICAL OXYGEN DEMAND
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

BIOCHEMISTRY
Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

BIOCIDES
Penetration of Biocides into Biofilm.
W91-05747 5D

BIODEGRADATION
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Biotechnology Approach to Bioremediation.
W91-05144 5G

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

Biodegradation of Land-Applied Sludge.
W91-05392 5E

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Biological Treatment of Mercury Waste.
W91-05692 5D

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Penetration of Biocides into Biofilm.
W91-05747 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Biological Removal of Iron from Groundwater.
W91-05751 5F

Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

Biological Treatment for Hazardous Wastes.
W91-05843 5D

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

BIOFILM REACTORS

Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

BIOFILMS

Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Penetration of Biocides into Biofilm.
W91-05747 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

BIOGAS

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

BIOGEOCHEMISTRY

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

BIOINDICATORS

Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

PCB Concentrations in Stream Sunfish (Lepomis auritus and L. macrochirus) in Relation to Proximity to Chronic Point Sources.
W91-04982 5B

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Can the United States Afford Biomonitoring.
W91-05143 5G

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

BIOLOGICAL FILTERS

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

BIOLOGICAL MEMBRANES

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

BIOLOGICAL OXIDATION

Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

BIOLOGICAL OXYGEN DEMAND

Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

BIOLOGICAL POLLUTION

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

BIOLOGICAL PROPERTIES

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

BIOLOGICAL TREATMENT

Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Biological Treatment of Mercury Waste.
W91-05692 5D

Biological Treatment for Hazardous Wastes.
W91-05843 5D

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

BIOLOGICAL WASTEWATER TREATMENT

Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Penetration of Biocides into Biofilm.
W91-05747 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

BIOMASS

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

BIOREMEDIATION

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Biotechnology Approach to Bioremediation.
W91-05144 5G

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

BIOTECHNOLOGY

Can the United States Afford Biomonitoring.
W91-05143 5G

Biotechnology Approach to Bioremediation.
W91-05144 5G

Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

BIOTRANSFORMATION
Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

BIRKENES MODEL
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

BIVALVES
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

BLACKWATER STREAMS
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

BLEACHING WASTES
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

BLOOD PRESSURE
Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

BOREHOLE GEOPHYSICS
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

BOREHOLES
Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

BOTSWANA
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

BOTTOM SEDIMENTS
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

BOTTOMLAND
Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

BOUNDARY ELEMENT METHOD
Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

BOUNDARY LAYERS
Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

BOUNDARY PROCESSES
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

BRACKISH WATER
Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

BRAZIL
Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

BRAZOS ISLAND HARBOR
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

BREAKTHROUGH CURVES
Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

BREAKWATERS
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

BROWNSVILLE SHIP CHANNEL
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

BUBBLES
Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

BUFFER ZONES
Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

BUOYANCY
Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

BUOYANT JETS
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

CADDISFLIES
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

CADMIUM
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

CAIRO
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

CALCARCAVEOUS SOILS
Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

CALCAREOUS SOILS
Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

CALCIUM
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

CALCIUM CARBONATE
Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

CALIBRATIONS
Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

CALIFORNIA
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

DHS Waste Reduction Program.
W91-05670 5G

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Regulation of Water Treatment Devices in California.
W91-05698 5F

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

CAMEROON
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

CANADA
Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

CANALS
Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

CAPE COD
Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

CAPILLARY ZONE
Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

CARBAMATE PESTICIDES
Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

CARBOFURAN
Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

CARBON
Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

CARBON CYCLE
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

CARBON MONOXIDE
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

CARBON RADIOISOTOPES
Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

CARBONATE ROCKS
Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

CARIBBEAN SEA
Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

CASE STUDIES
Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

CATALYSTS
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

CATCHMENT AREAS
Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

CATECHOLS
Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

CATION EXCHANGE
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

CATIONS
Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

CATTLE
Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

CAVES
Origin and Morphology of Limestone Caves.
W91-05851 2F

CAYMAN ISLANDS
Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

CELLULOSE
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

CEMENT INDUSTRY
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

CEMENTS
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

CERRILLOS DAM
Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

CESIUM RADIOISOTOPES
Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

CHABAZITE
Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

CHANGJIANG RIVER
Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

CHANNEL FLOW
Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

CHANNEL IMPROVEMENT
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

CHANNEL INFLOW
Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

CHANNEL MORPHOLOGY
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

Bed Features in Nonuniform Sediments.
W91-05426 2E

Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

CHANNEL STABILITY
Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

CHARA
Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

CHAUTAUQUA LAKE
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

CHELATING AGENTS
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

CHEMICAL ANALYSIS
Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

CHEMICAL COAGULATION
Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

Sewage Clarification with Magnetite Particles.
W91-05780 5D

Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

CHEMICAL INTERACTIONS
Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

CHEMICAL INTERFERENCE
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

CHEMICAL OXYGEN DEMAND
Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

CHEMICAL PRECIPITATION
Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

CHEMICAL PROPERTIES
Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

CHEMICAL REACTIONS
Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

CHEMICAL TREATMENT
Use of Chloramines - Past, Present and Future.
W91-05212 5F

Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

CHEMICAL WASTEWATER
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

CHEMISTRY OF PRECIPITATION
Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

CHERNOZEM
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

CHERNOZEMS
Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

CHESAPEAKE BAY
Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

CHINA
Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

CHITOSAN
Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

CHLORAMINES
Use of Chloramines - Past, Present and Future.
W91-05212 5F

CHLORELLA
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

CHLORIDES
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

CHLORINATED HYDROCARBONS
Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

CHLORINATION
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Use of Chloramines - Past, Present and Future.
W91-05212 5F

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

CHLORINE
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

CHLOROFORM
Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

CHLOROPHYTA
Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

CHLORPYRIFOS
History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

CHROMIUM
Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

CHRONIC TOXICITY
Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

CHU RIVER VALLEY
Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

CIRCADIAN RHYTHMS
Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

CIVIL ENGINEERING
What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

CLAMS
Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

CLARIFICATION
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Sewage Clarification with Magnetite Particles.
W91-05780 5D

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

CLARIFIERS
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

CLASSIFICATION
Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

CLAY
Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

CLAY LINERS
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

CLAY MINERALS
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

CLAY SOILS
Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

CLAYS
Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

CLEANUP
Biotechnology Approach to Bioremediation.
W91-05144 5G

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

CLEANUP OPERATIONS
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

Groundwater Remediation Plan.
W91-05033 5G

Making Groundwater Safe to Drink.
W91-05034 5G

Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies.
W91-05236 5G

Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

CLIMATE CHANGE
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

CLIMATE CHANGES
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

CLIMATIC CHANGE
Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

CLIMATIC CHANGES
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

CLIMATIC DATA
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

CLIMATOLOGY
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

Role of Temperature for Drought Study.
W91-05627 2E

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

CLOSTRIDIUM
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

CLOUD COVER
Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

CLOUD LIQUID WATER
Updating the Smith-Feddes Model.
W91-05277 2B

CLOUD PHYSICS
Updating the Smith-Feddes Model.
W91-05277 2B

Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

CLOUD SEEDING
Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

CLOVERS
Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

COAGULATION
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

COAL ASH
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

COAL TARS
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

COASTAL AQUIFERS
Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

COASTAL AREAS
Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

COASTAL ENGINEERING
Wave Forces on a Wall.
W91-05785 8B

COASTAL ENVIRONMENT
Saline Maritime Soils of Estonia.
W91-05229 2G

COASTAL MARSHES
Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

COASTAL STREAMS
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

COASTAL WATERS
Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

COASTAL WETLANDS
Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

COASTAL ZONE MANAGEMENT
Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

COASTS
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

COBALT RADIOISOTOPES
Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

COHESIVE SOILS
Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

COKE PLANT WASTEWATER
Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

COLD REGIONS
Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

COLIFORMS
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

COLLAPSE
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

COLLOIDS
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

COLOMBIA
Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

COLONIZATION
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

COLORADO
Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

COLORIMETRY
Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

COMMUNICATION
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Developing a Risk Communication Strategy.
W91-05020 5F

Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

COMPACTION
Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

COMPARISON STUDIES
Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

COMPETITION
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

COMPONENT INTERACTION MATRIX
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

COMPOST
Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

COMPOSTING
Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

COMPREHENSIVE ANALYSIS OF MIGRATION PATHWAYS
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

COMPREHENSIVE PLANNING
Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

COMPRESSIBILITY
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

COMPUTED TOMOGRAPHY
Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

COMPUTER-AIDED DESIGN
Heuristic Design of Sewer Networks.
W91-05328 5D

Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

COMPUTER MODELS
Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

COMPUTER PROGRAMS
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

COMPUTERS
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

CONCRETE CONSTRUCTION
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

CONCRETES
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

CONCRETES

Concrete-Faced Rockfill Dam.
W91-05116 8A

Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

CONDUCTIVITY

Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

CONFERENCES

Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

CONFINED AQUIFERS

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

CONIFEROUS FORESTS

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

CONSERVATION

Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

CONSOLIDATION

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

CONSTRUCTION COSTS

Optimization of the Designs of Earth Dams.
W91-05083 8A

CONSTRUCTION MATERIALS

Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

CONSTRUCTION METHODS

Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

CONTAMINATION

Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

CONTINENTAL MARGIN

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

CONTINENTAL SLOPE

Gulf of Lions' Hydrodynamics.
W91-05452 2L

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

CONTROL SYSTEMS

Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

Computerised Instrumentation and Control Systems.
W91-05293 7B

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

CONVECTION

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

COOLING WATER

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

COPPER

Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

CORALS

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

CORN

USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

CORRELATION ANALYSIS

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

CORROSION

Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

CORROSION CONTROL

Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

COST ANALYSIS

Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

Economics of Desalination for Three Plant Sizes.
W91-05196 3A

Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

COST-BENEFIT ANALYSIS
Measurement of Operator Training Benefits.
W91-05508 5G

Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

COTTON
Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

COUNCIL FOR HEALTH AND ENVIRONMENTAL SAFETY OF SOILS
Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

COWPEA
Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

CRABS
Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

CRAE MODEL
Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

CRAYFISH
Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

CRESOLS
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

CROP PRODUCTION
Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

CROP YIELD
USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

CROPLAND
Theoretical Principles of Water Erosion Control on Cropland.
W91-05827 4D

Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

CROPS
Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

CRUSTACEANS
Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

CUBA
Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

CULTIVATED LAND
Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

CULVERTS
Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

CUTOFFS
Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

CYANIDE
Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

CYANOPHYTA
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

CYCLING NUTRIENTS
Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

CYTOCHROMES
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

DAIRY INDUSTRY
Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

DAM CONSTRUCTION
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

Concrete-Faced Rockfill Dam.
W91-05116 8A

Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

DAM DESIGN
Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

Optimization of the Designs of Earth Dams.
W91-05083 8A

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

DAM EFFECTS
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

DAM FAILURE
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

DAM FOUNDATIONS
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

DAM-RESERVOIR INTERACTIONS
Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

DAM STABILITY
Anchoring a Dam.
W91-05069 8A

Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

DAMS
Calculated Prediction of Earth Pressures on Tailwater Tunnels of the Rogun Hydroelectric Station.
W91-05076 8E

DANUBE RIVER BASIN
Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

DAPHNIA
Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

DARLING RIVER BASIN
Optical Properties of Waters in the Murray-Darling Basin, South-Eastern Australia.
W91-05004 2E

DATA ACQUISITION
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

DATA ANALYSIS
Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

DATA COLLECTIONS
Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

DATA INTERPRETATION
Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

DATA PROCESSING
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

DATABASES
Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

DDT
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

DEBRIS AVALANCHES
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

DEBRIS CONES
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

DECHLORINATION
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

DECISION MAKING
Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

DECOMPOSING ORGANIC MATTER
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

Biodegradation of Land-Applied Sludge.
W91-05392 5E

DECOMPOSITION
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

DECONTAMINATION
Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

DEFOLIATION
Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

DEFORMATION
Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

DEICERS
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

DELAWARE
Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

DELAWARE BAY
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

DELAWARE RIVER ESTUARY
Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

DEMINERALIZATION
Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

DENITRIFICATION
Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

DENMARK
Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

DENSITY
Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

DEPOSITION
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

DESALINATION
Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

Economics of Desalination for Three Plant Sizes.
W91-05196 3A

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

DESALINATION APPARATUS
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

DESALINATION PLANTS
Economics of Desalination for Three Plant Sizes.
W91-05196 3A

DESERTIFICATION
Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

DESERTS
Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

DESIGN CRITERIA
Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

DESIGN FLOW
Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

DESIGN STANDARDS
Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

DESORPTION
Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

DESULFURIZATION
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

DETENTION RESERVOIRS
Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

DETENTION TIME
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

DETERGENTS
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

DETRITUS
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

DEVELOPING COUNTRIES

Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

DEWATERING

Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

DIATOMS

Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

DIFFUSION

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Penetration of Biocides into Biofilm.
W91-05747 5D

DIFFUSION COEFFICIENT

Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

DIGESTED SLUDGE

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

DIGESTER GAS

Gas Metering at Sewage Purification Works.
W91-05291 5D

DIGESTERS

Gas Metering at Sewage Purification Works.
W91-05291 5D

Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

DINOFLAGELLATES

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

DIOXINS

Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

DISCHARGE MEASUREMENT

Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

DISINFECTION

Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

Use of Chloramines - Past, Present and Future.
W91-05212 5F

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

DISPERSION

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

DISPOSAL WELLS

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

DISSOLVED ORGANIC CARBON

Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

DISSOLVED ORGANIC MATTER

Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

DISSOLVED OXYGEN

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

DISSOLVED SOLIDS

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

DISTILLATION

Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

DISTRIBUTION PATTERNS

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

DIURNAL VARIATION

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

DNA
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

DOMESTIC WASTES
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

DOMESTIC WATER
What is a Water Audit.
W91-05211 3D

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

DOMINICAN REPUBLIC
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

DRAINAGE
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

DRAINAGE WATER
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

DREDGING
Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

DREDGING WASTES
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

DRILLING FLUIDS
Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

DRINKING WATER
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

Making Groundwater Safe to Drink.
W91-05034 5G

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

Translating Research into Practice: The Drinking Water Industry.
W91-05279 5F

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Point-of-Use/Entry Treatment of Drinking Water.
W91-05694 5F

Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Performance and Application of RO Systems.
W91-05707 5F

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

DRINKING WATER

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

DROUGHT

Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

Role of Temperature for Drought Study.
W91-05627 2E

DROUGHT EFFECTS

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

DROUGHT RESISTANCE

Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

DROUGHT STRESS

Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

DRY BED FILTRATION

Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

DRY DEPOSITION

Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

DRYING

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

DYE INDUSTRY WASTES

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

DYNAMIC PROGRAMMING

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

EARTH DAMS

Optimization of the Designs of Earth Dams.
W91-05083 8A

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

EARTH-WATER INTERFACES

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

EARTHQUAKE ENGINEERING

Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

EARTHQUAKES

Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

EARTHWORKS

Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

Reliability of the Assurance of Stability of Earth Masses.
W91-05088 8D

Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

EARTHWORMS

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

EAST AFRICA

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

EAU GALLE RESERVOIR

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

EBRO RIVER

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

ECOLOGICAL EFFECTS

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

ECOLOGY

Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

ECONOMIC ASPECTS

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

Optimization of the Designs of Earth Dams.
W91-05083 8A

Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

Economics of Desalination for Three Plant Sizes.
W91-05196 3A

Toward Economically Efficient Management of Underground Storage Tanks: A Risk-Based Approach.
W91-05264 5G

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

Valuing Potenial Groundwater Protection Benefits.
W91-05831 6B

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

ECONOMIC EVALUATION
Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

ECONOMIC IMPACT
Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

ECOSYSTEMS
Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

ECOTOXICOLOGY
Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

EDUCATION
Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

EFFLUENTS
Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

EGGS
Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

EGYPT
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

Greater Cairo Wastewater Project.
W91-05804 5D

EL NINO/SOUTHERN OSCILLATION
USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

ELASTICITY OF DEMAND
User-Specific Water Demand Elasticities.
W91-05790 6D

ELECTRICAL INDUSTRY
EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

ELECTROCHEMISTRY
Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

ELECTRODES
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

ELECTRODIALYSIS
Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

ELECTROLYSIS
Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

ELECTROPHILES
Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

EMBANKMENTS
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

EMISSIONS CONTROL
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

ENDANGERED SPECIES
Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

ENERGY COSTS
Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

ENERGY EQUATION
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

ENERGY RECOVERY
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

ENERGY SOURCES
Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

ENERGY USE EFFICIENCY
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

ENGINEERING GEOLOGY
System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

ENGLAND
Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Soil Controls on Recharge to Aquifers.
W91-05469 2F

Revival of Incineration in the UK.
W91-05507 5D

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

ENRICHMENT
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

ENTERIC BACTERIA
Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

ENTRAINMENT
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

Bed Features in Nonuniform Sediments.
W91-05426 2E

ENVIRONMENTAL CHEMISTRY
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

ENVIRONMENTAL DATA
Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

ENVIRONMENTAL EFFECTS
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Floods Threatening Kashmir Wetlands.
W91-05385 2E

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

Impact of Man.
W91-05872 4C

ENVIRONMENTAL ENGINEERING
Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Heuristic Design of Sewer Networks.
W91-05328 5D

Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

ENVIRONMENTAL IMPACT
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

ENVIRONMENTAL POLICY
Developing a Risk Communication Strategy.
W91-05020 5F

Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

ENVIRONMENTAL PROTECTION
Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

USEPA Pollution Prevention Research Program.
W91-05669 5G

DHS Waste Reduction Program.
W91-05670 5G

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

ENVIRONMENTAL QUALITY
Environmental Health.
W91-05051 6G

ENVIRONMENTAL TRACERS
Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

ENZYMES
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

EPIDEMIOLOGY
Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

EPOXY
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

EROSION
Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

EROSION CONTROL

Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

Theoretical Principles of Water Erosion Control on Cropland.
W91-05827 4D

Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

ERROR ANALYSIS

Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

ERRORS

Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

ESCHERICHIA COLI

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

ESTIMATING EQUATIONS

Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

ESTONIA

Saline Maritime Soils of Estonia.
W91-05229 2G

ESTUARIES

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

Tidal Hydraulics of Saint John River.
W91-05783 2L

ESTUARINE ENVIRONMENT

Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

ESTUARINE FISHERIES

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

ESTUARINE SEDIMENTS

Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

ETHYLENE

Production and Stability of Ethylene in Soil.
W91-05337 2G

EUPHOTIC ZONE

Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

EUROPE

Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

EUROPIUM

Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

EUTROPHIC LAKES

Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

EUTROPHICATION

Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

EVALUATION
Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

EVAPORATION
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

EVAPOTRANSPIRATION
Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

EVAPOTRANSPIRATION POTENTIAL
Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

EVERGLADES
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

EXCESS RAINFALL
Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

EXCESS WATER
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

EXXON VALDEZ
Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

FACINGS
Concrete-Faced Rockfill Dam.
W91-05116 8A

FALLOUT
Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

FARM WASTES
Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

FATE OF POLLUTANTS
Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Degradation of Terbacil in Soil.
W91-05226 5B

Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

FATTY ACIDS
Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

FEASIBILITY STUDIES
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

FECAL BACTERIA
Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

FECAL COLIFORMS
Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

FEDERAL JURISDICTION
USEPA Pollution Prevention Research Program.
W91-05669 5G

FEEDLOT RUNOFF
Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

FENS
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

FENTONS REAGENT
Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

FERRITE PROCESS
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

FERTILIZATION
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

FERTILIZERS
Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

Question of Nitrates.
W91-05904 5B

FIBER CROPS
Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

FIBROUS BEDS
Application of Fibrous Adsorbents in Water Treatment.
W91-05774 5D

FIELD TESTS
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

FILTER MEDIA
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

FILTRATION
Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

FINANCIAL ASPECTS
Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

FINANCING
ABCs of SRFs.
W91-05071 5D

FINITE DIFFERENCE METHODS
Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

FINLAND
Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

FISH

Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

FISH CONSERVATION

Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

FISH FOOD

Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

FISH HARVESTING

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

FISH LARVAE

Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

FISH MANAGEMENT

Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

FISH MIGRATION

Spring Growing Period as a Regulator of the Size of the Smolt Run in Trout (Salmo trutta).
W91-05000 2H

FISH POPULATIONS

Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

FISHERIES

Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

FISSURE WATER

Origin and Morphology of Limestone Caves.
W91-05851 2F

FLASH FLOODS

Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

FLOCCULATION

Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

FLOOD CONTROL

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

FLOOD DAMAGE

Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Floods Threatening Kashmir Wetlands.
W91-05385 2E

FLOOD FLOW

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

FLOOD FORECASTING

Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

FLOOD FREQUENCY

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

FLOOD PEAK

Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

FLOOD PLAIN MANAGEMENT

Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

FLOOD RECURRENCE INTERVAL
Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

FLOOD ROUTING
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

FLOOD WARNING SYSTEMS
Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

FLOOD WAVES
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

FLOODING
Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

FLOODS
Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

FLORIDA
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

Florida's Funding for Contamination Correction.
W91-05716 5F

Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

FLOW CHARACTERISTICS
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

FLOW CONTROL
Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

FLOW EQUATIONS
Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

FLOW FRICTION
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

FLOW MEASUREMENT
Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

FLOW MEASUREMENTS
Volume Recorder for Lysimeter Waters.
W91-05189 2G

Gas Metering at Sewage Purification Works.
W91-05291 5D

FLOW MODELS
Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

FLOW PATTERN
Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

FLOW PROFILES
Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

FLOW RATES
Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

FLOW RESISTANCE
Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

FLOW VELOCITY
Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

FLUID DROPS
Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

FLUID DYNAMICS
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

FLUID FLOW
Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

FLUID MECHANICS
Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

FLUIDIZED BED PROCESS
Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

FLUIDIZED BEDS
Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

FLUORESCENCE SPECTROSCOPY
Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

FLUORIDES
Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

FLUOROMETRY
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

FLUVIAL SEDIMENTS
Bed Features in Nonuniform Sediments.
W91-05426 2E

FLY ASH
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

FOAMING
Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

FOG
Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

FOOD-PROCESSING WASTES
Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

FOREIGN RESEARCH
Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

FOREST ECOSYSTEMS
Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

FOREST HYDROLOGY
Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

FOREST MANAGEMENT
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

FOREST SOILS
Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

FOREST WATERSHEDS
Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

FORESTRY
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

FORESTS
Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

FORMAZAN
Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

FOUNDATION FAILURE
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

FOUNDATION ROCKS
System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

FOUNDATIONS
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

FRAGILARIA
Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

FRANCE
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

FREEZING
Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

Solute Rejection in Freezing Soils.
W91-05840 2K

FRENCH POLYNESIA
Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

FRESHWATER LENSES
Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

FROUDE NUMBER
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

FROZEN GROUND
Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Solute Rejection in Freezing Soils.
W91-05840 2K

FULVIC ACIDS
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

FUNGI
Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

FURROW IRRIGATION
Rice and Furrow Irrigation Management.
W91-05159 3F

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

FUTURE PLANNING
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Portland Water District's Water Distribution Master Plan.
W91-05210 5F

GAS CHROMATOGRAPHY
Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

GASES
Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

GASOLINE
Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

GASTROPODS
Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

GENES
Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

GEOCHEMISTRY
Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

Origin and Morphology of Limestone Caves.
W91-05851 2F

GEOGRAPHIC INFORMATION SYSTEMS
Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

GEOHYDROLOGIC BOUNDARIES
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

GEOHYDROLOGY
Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

Origin and Morphology of Limestone Caves.
W91-05851 2F

GEOLOGIC FRACTURES

Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

GEOLOGIC HISTORY

Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

GEOLOGIC MAPPING

New State Geologic Map for Mississippi: A Tool for Updating Nomenclature and Definitions of the State's Aquifers and Aquitards.
W91-05158 7C

GEOLOGIC SURVEYS

Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

GEOLOGICAL SURVEYS

State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

GEOMAN PROGRAM

Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

GEOMORPHOLOGY

Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

GEOPHYSICAL METHODS

Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

GEOPHYSICAL SURVEYS

Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

GEOPHYSICS

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

GEOSTATISTICS

Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

GEOTHERMAL STUDIES

Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

GEOTHERMAL WATER

Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

GERMANY

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

GHANA

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

GIARDIA

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

GLACIAL LAKES

Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

GLACIER SURGES

Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

GLACIERS

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

GLACIOHYDROLOGY

Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

GLOBAL WARMING

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

GOETHITE

Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

GOLD
Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

GOLD MINING
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

GOVERNMENTAL INTERRELATIONS
Water Supply Challenge in the Gulf Region.
W91-05192 3D

GRAIN CROPS
Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

GRAND CAYMAN ISLAND
Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

GRANULAR ACTIVATED CARBON
Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

GRASSLANDS
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

GRAVELS
Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

GRAVITY SURVEYS
New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

GREAT EXUMA ISLAND
Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

GREAT PLAINS
Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

GREENHOUSE EFFECT
Climatic Sensitivity of California Water Resources.
W91-05793 6B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

GREENLAND
Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

GROUNDWATER
Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

Biological Removal of Iron from Groundwater.
W91-05751 5F

GROUNDWATER CHEMISTRY
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

GROUNDWATER LEVEL
Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

GROUNDWATER MANAGEMENT
Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

GROUNDWATER MOVEMENT
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Volume Recorder for Lysimeter Waters.
W91-05189 2G

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

One-Dimensional Tracer Model.
W91-05815 2F

Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

Origin and Morphology of Limestone Caves.
W91-05851 2F

Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

GROUNDWATER POLLUTION

Groundwater Remediation Plan.
W91-05033 5G

Making Groundwater Safe to Drink.
W91-05034 5G

Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

Toward Economically Efficient Management of Underground Storage Tanks: A Risk-Based Approach.
W91-05264 5G

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Miscible Displacement with Density and Viscosity Contrasts. Estimation of Displacement Parameters and Stability in Mechanical Dispersion Regime (Deplacement Miscible Avec Contrastes de Densite et de Viscosite en Milieu Poreux. Identification des Parametres de Deplacement et Stabilite en Regime de Dispersion Mecanique).
W91-05435 5B

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

Question of Nitrates.
W91-05904 5B

Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

GROUNDWATER POTENTIAL

Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

GROUNDWATER PROTECTION

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

GROUNDWATER QUALITY

Making Groundwater Safe to Drink.
W91-05034 5G

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

GROUNDWATER RECHARGE

Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Soil Controls on Recharge to Aquifers.
W91-05469 2F

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Ground Water Recharge with Sewage Effluent.
W91-05538 3C

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

GROUNDWATER RESEARCH

Center for Aquifer Science and Technology (CAST).
W91-05795 9C

GROUNDWATER RESOURCES

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

GROUNDWATER STORAGE

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

GULF COOPERATION COUNCIL

Water Supply Challenge in the Gulf Region.
W91-05192 3D

GULF OF FINLAND

Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

GULF OF LIONS

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

Gulf of Lions' Hydrodynamics.
W91-05452 2L

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

GULF OF MEXICO

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

GYPSUM

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

HABITAT RESTORATION

Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

HALOGENATED COMPOUNDS

Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

HALOGENATED HYDROCARBONS

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

HALOGENATED PESTICIDES

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

HANDBOOKS

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

HARBORS

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

HAWAII

Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

HAZARD ASSESSMENT

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

HAZARDOUS WASTE DISPOSAL

Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

HAZARDOUS WASTE TREATMENT

Biological Treatment for Hazardous Wastes.
W91-05843 5D

HAZARDOUS WASTES

Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Biological Treatment for Hazardous Wastes.
W91-05843 5D

HEADWATER STREAMS
Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

HEAT TREATMENT
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

HEAVY METALS
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Solids Detoxification: Metals Recovery.
W91-05680 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

HELMINTHS
Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

HENDRIKSDAL
Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

HERBICIDES
Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Degradation of Terbacil in Soil.
W91-05226 5B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

HERMITE INTERPOLATION
Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

HETEROTROPHIC BACTERIA
Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY
Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

HIGH PLAINS
Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

HIGHWAY EFFECTS
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

HIGHWAY ICING
Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

HISTORIC FLOODS
Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

HISTORY
Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

HOGS
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

HOLOCENE EPOCH
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

HORNADAY MOUNTAINS
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

HOT MIX ASPHALT
Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

HUANG HE RIVER
Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

HUMAN DISEASES
Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Question of Nitrates.
W91-05904 5B

HUMAN PATHOGENS
Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

HUMAN POPULATION
Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

HUMIC ACIDS
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

HUMIC SUBSTANCES
Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

HUMID AREAS
Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

HUMID CLIMATES
International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

HUMIDITY
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

HURRICANES
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

HYDRAULIC CONDUCTIVITY
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

HYDRAULIC DESIGN
Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

Heuristic Design of Sewer Networks.
W91-05328 5D

Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

HYDRAULIC ENGINEERING
Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

Wave Forces on a Wall.
W91-05785 8B

Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

Parameter Estimation for Water Distribution Networks.
W91-05794 5F

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

HYDRAULIC FILL
Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

HYDRAULIC FRACTURING
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

HYDRAULIC JUMP
Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

HYDRAULIC LOADING
Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

HYDRAULIC MODELS
Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

HYDRAULIC PROFILES
Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

HYDRAULIC PROPERTIES
Stability of Free Surface Sediment Flow.
W91-05170 2J

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

HYDRAULIC ROUGHNESS
Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

HYDRAULIC STRUCTURES
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

Wave Forces on a Wall.
W91-05785 8B

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

HYDROCARBONS
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

HYDRODYNAMICS
Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Gulf of Lions' Hydrodynamics.
W91-05452 2L

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

HYDROELECTRIC PLANTS
Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

HYDROGEN ION CONCENTRATION
Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

HYDROGEN PEROXIDE
Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

HYDROGEN SULFIDE
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

HYDROGRAPHS
ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

HYDROGRAPHY
Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

HYDROLOGIC BUDGET
Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

Impact of Man.
W91-05872 4C

Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

HYDROLOGIC CYCLE
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

HYDROLOGIC MODELS
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

HYDROLOGIC SYSTEMS
Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

HYDROLOGICAL REGIME
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

HYDROLOGY
Origin and Morphology of Limestone Caves.
W91-05851 2F

HYDROLYSIS
Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

IBARAKI
239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

ICE
Monitoring River Ice with Landsat Images.
W91-05031 2C

Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

ICE COVER
Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

ICE FORMATION
Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

ILLINOIS
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

IMMUNOLOGY
Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

IMPAIRED WATER USE
Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

IMPEDANCE
Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

IMPERVIOUS SOILS
Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

IN SITU REPAIR
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

IN SITU TREATMENT
Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

INCINERATION
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

Revival of Incineration in the UK.
W91-05507 5D

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

INDIA
Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

Floods Threatening Kashmir Wetlands.
W91-05385 2E

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

INDIAN RIVER LAGOON
Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

INDIANA
Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

INDUSTRIAL DEVELOPMENT
Impact of Man.
W91-05872 4C

INDUSTRIAL PLANTS
Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

INDUSTRIAL WASTES
Groundwater Remediation Plan.
W91-05033 5G

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

INDUSTRIAL WASTEWATER
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

INDUSTRIAL WATER
Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

INFILTRATION
Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

Hillslope Infiltration: Planar Slopes.
W91-05841 2G

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

INFILTRATION RATE

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

INHIBITION

Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

INHIBITORS

Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

INSECTICIDES

Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

INSTITUTIONS

Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

INSTREAM AERATION

Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

INSTRUMENTATION

Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

Gas Metering at Sewage Purification Works.
W91-05291 5D

Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

Computerised Instrumentation and Control Systems.
W91-05293 7B

Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

INSULATION

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

INSURANCE

Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

INTERAGENCY COOPERATION

Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

INTERDISCIPLINARY STUDIES

Center for Aquifer Science and Technology (CAST).
W91-05795 9C

Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

INTERNATIONAL AGREEMENTS

International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

INTERSTATE COMMISSIONS

Improving Strategies for Chemical Spills.
W91-05035 5G

INTERSTITIAL WATER

Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

INTERTIDAL AREAS
Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

INTRACELLULAR GRANULES
Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

INVERTEBRATES
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

ION EXCHANGE
Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

ION EXCHANGE CHROMATOGRAPHY
Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

ION TRANSPORT
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

IONIZATION
Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

IONS
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

IRELAND
Spring Growing Period as a Regulator of the Size of the Smolt Run in Trout (Salmo trutta).
W91-05000 2H

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

IRON
Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Biological Removal of Iron from Groundwater.
W91-05751 5F

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

IRON BACTERIA
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

IRON COMPOUNDS
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

IRRIGATION
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

IRRIGATION CANALS
Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

IRRIGATION DESIGN
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Reservoir Planning for Irrigation District.
W91-05791 6A

Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

IRRIGATION EFFECTS
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

IRRIGATION EFFICIENCY
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

Rice and Furrow Irrigation Management.
W91-05159 3F

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

IRRIGATION ENGINEERING
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

IRRIGATION MANAGEMENT
Rice and Furrow Irrigation Management.
W91-05159 3F

IRRIGATION PRACTICES
Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

IRRIGATION PROGRAMS
Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

IRRIGATION REQUIREMENTS
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

IRRIGATION RUNOFF
Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

IRRIGATION WATER
Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

Chemical Analysis of Irrigation Waters in Bahrain.
W91-05545 3F

Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

ISLAND HYDROLOGY
Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

ISLANDS
Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

ISOTOPE RATIOS
Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

ISOTOPE STUDIES
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

ISRAEL
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

ITALY
Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

JAMAICA BAY
Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

JAPAN
Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

JAPAN

Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

JETS

Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

KANSAS

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

KARST

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Origin and Morphology of Limestone Caves.
W91-05851 2F

KARST HYDROLOGY

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

KELPS

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

KENAF

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

KEROSENE

Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

KEY WEST

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

KINEMATIC WAVES

Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

KINETICS

Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

KOREA

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

KUWAIT

Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

KYOTO

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

LABORATORY METHODS

Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

LAGOONS

Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

LAGOS LAGOON

Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

LAKE ACIDIFICATION

Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

LAKE BIWA

Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

LAKE ERIE

Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

LAKE FISHERIES

Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

LAKE ICE
Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

LAKE KASUMIGAURA
Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

LAKE MANAGEMENT
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

LAKE MANZALA
Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

LAKE MICHIGAN
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

LAKE RESTORATION
Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

LAKE SEDIMENTS
Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

LAKE SHORES
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

LAKE STRATIFICATION
Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

LAKE SUPERIOR
Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

LAKE TUUSULANJARVI
Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

LAKE VEGORITIS
Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

LAKES
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

LANANA CREEK
Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

LAND APPLICATION
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

LAND DEVELOPMENT
Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

LAND DISPOSAL
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

Biodegradation of Land-Applied Sludge.
W91-05392 5E

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

LAND TREATMENT
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

LAND USE
Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

LANDFILL COVERS
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

LANDFILL LINERS
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

LANDFILLS
Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

LANDFILLS

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

LANDSAT IMAGES
Monitoring River Ice with Landsat Images.
W91-05031 2C

LANDSCAPES
Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

LANDSLIDES
Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

LANFILLS
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

LAPLACE TRANSFORM GALERKIN TECHNIQUE
Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

LARVAE
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

LASERS
Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

LEACHATES
Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

LEACHING
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Modeling of Mass-Exchange of Phases in a Soloneteic Soil Leached after Application of Gypsum.
W91-05354 2G

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

LEAD
Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

LEAD RADIOISOTOPES
210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

LEAKAGE
Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

What is a Water Audit.
W91-05211 3D

LEAKS
Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

LEAKY AQUIFER SYSTEMS
Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

LEAVES
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

LEGAL ASPECTS
Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

Brief Review of Water Rights in New Hampshire.
W91-05213 6E

Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

LEGISLATION
Brief Review of Water Rights in New Hampshire.
W91-05213 6E

N. H. Water Rights: An Endangered Species.
W91-05214 6E

Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

LEGUMES
Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

LIABILITY
Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

LIGHT EFFECTS
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

LIGHT INTENSITY
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

LIGHTING
Lighting Guide for Wastewater Treatment Facilities.
W91-05029 5D

LIGNIN
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

LIME
Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

LIMESTONE
Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Origin and Morphology of Limestone Caves.
W91-05851 2F

LIMING
Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

LIMNOLOGY
Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

LINEAR ALKYL SULFONATES
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

LINEAR PROGRAMMING
Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

LINERS
Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

LIPIDS
Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

LIQUID CHROMATOGRAPHY
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

LITERATURE REVIEW
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

LITTER
Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

LITTORAL ZONE
Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

LOAD TESTING
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

LOAM
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

LOCKS
Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

LOGGING (RECORDING)
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

LONG ISLAND
Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

LOOSDRECHT LAKES
Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

LOS ANGELES
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

LOUISIANA
Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

LOW-CLINKER CEMENT
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

LOW FLOW
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

LUQUILLO EXPERIMENTAL FOREST
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

LYSIMETERS
Volume Recorder for Lysimeter Waters.
W91-05189 2G

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

MACQUARIE ISLAND
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

MACROINVERTEBRATES
Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

MACROPHYTE SPECIES
Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

MACROPHYTES
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

MACROPORES
Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

MADAGASCAR
Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

MAGELA CREEK
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

MAGNESIUM
Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

MAGNETITE
Sewage Clarification with Magnetite Particles.
W91-05780 5D

MAHAWELI RESERVOIRS
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

MAINE
Portland Water District's Water Distribution Master Plan.
W91-05210 5F

Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

MAINTENANCE
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

MALI
Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

MANAGEMENT PLANNING
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

MANGANANESE
Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

MANGANESE
Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

MANGROVE SWAMPS
Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associat-

ed with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

MANUALS
California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

MANURE
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

MAPPING
Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

MARINE CLIMATES
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

MARINE ENVIRONMENT
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

MARINE FISHERIES
Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

MARINE POLLUTION
Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

MARINE SEDIMENTS
Characteristics of a Marshland Soil Built Up from Marine and Peat Material.
W91-05568 2H

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

MARKOV PROCESS
Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

MARSH PLANTS
Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

MARSHES
Characteristics of a Marshland Soil Built Up from Marine and Peat Material.
W91-05568 2H

MASS EXCHANGE
Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

MASS SPECTROMETRY
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

MASS TRANSFER
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

MASS TRANSPORT
Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

MASSACHUSETTS
Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

What is a Water Audit.
W91-05211 3D

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

MATERIALS TESTING
Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

MATHEMATICAL ANALYSIS
One-Dimensional Tracer Model.
W91-05815 2F

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

Hillslope Infiltration: Planar Slopes.
W91-05841 2G

Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

MATHEMATICAL EQUATIONS
Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

MATHEMATICAL MODELS
Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Stability of Free Surface Sediment Flow.
W91-05170 2J

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

Parameter Estimation for Seasonal to Subseasonal Disaggregation.
W91-05431 7C

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

Solute Rejection in Freezing Soils.
W91-05840 2K

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

MATHEMATICAL STUDIES

Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

MAXIMUM PROBABLE FLOODS

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

MEASURING INSTRUMENTS

Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

Volume Recorder for Lysimeter Waters.
W91-05189 2G

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

Continuous Water Quality Monitoring.
W91-05287 5G

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

Gas Metering at Sewage Purification Works.
W91-05291 5D

Computerised Instrumentation and Control Systems.
W91-05293 7B

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

MEDICAL WASTES

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

MEDITERRANEAN

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

MEDITERRANEAN SEA

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

Gulf of Lions' Hydrodynamics.
W91-05452 2L

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

MELTING

Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

MELTWATER

Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

MEMBRANE DISTILLATION

Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

MEMBRANE FILTERS

Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

MEMBRANE PROCESSES

Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Performance and Application of RO Systems.
W91-05707 5F

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

MEMBRANES

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

MENHADEN

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

MERCURY

Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

Biological Treatment of Mercury Waste.
W91-05692 5D

Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

METABOLISM

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

METAL COMPLEXES

Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

METAL-FINISHING WASTES

pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

USEPA Pollution Prevention Research Program.
W91-05669 5G

DHS Waste Reduction Program.
W91-05670 5G

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Solids Detoxification: Metals Recovery.
W91-05680 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Biological Treatment of Mercury Waste.
W91-05692 5D

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

METAL-ORGANIC COMPLEXES

Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

METALS

Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

METEORIC WATER

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

METEOROLOGICAL DATA

Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

METEOROLOGICAL DATA COLLECTION

Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

METEOROLOGY

Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

Role of Temperature for Drought Study.
W91-05627 2E

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

METHANE

Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

METHANE BACTERIA

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

METHANE THIOL

Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

METHANOGENESIS

Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

METHIDATHION

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

METRIBUZIN

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

METROPOLITAN WATER MANAGEMENT

Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

Greater Cairo Wastewater Project.
W91-05804 5D

Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

MEUSE RIVER
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

MEVINPHOS
Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

MEXICO
La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

MICHIGAN
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

MICROBIAL DEGRADATION
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Degradation of Terbacil in Soil.
W91-05226 5B

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Biodegradation of Land-Applied Sludge.
W91-05392 5E

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

MICROBIOLOGICAL STUDIES
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

MICROCLIMATOLOGY
Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

MICROFILTRATION
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

MICRONESIA
Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

MICROORGANISMS
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

MICROWAVES
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

MIDDLE EAST
Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

MILITARY RESERVATIONS
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

MINE DRAINAGE
Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

MINE WASTES
Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

MINERAL EXPLORATION
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

MINERALIZATION
Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

MINERALOGY
Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

MINERALS
Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

MINING EFFECTS
Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

MINNESOTA
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

MISSISSIPPI
Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Biotechnology Approach to Bioremediation.
W91-05144 5G

Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

New State Geologic Map for Mississippi: A Tool for Updating Nomenclature and Definitions of the State's Aquifers and Aquitards.
W91-05158 7C

Rice and Furrow Irrigation Management.
W91-05159 3F

Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

MISSISSIPPI RIVER

Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

MIXING

Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

MODEL STUDIES

Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

Stability of Free Surface Sediment Flow.
W91-05170 2J

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

Portland Water District's Water Distribution Master Plan.
W91-05210 5F

Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

Updating the Smith-Feddes Model.
W91-05277 2B

Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

Parameter Estimation for Seasonal to Subseasonal Disaggregation.
W91-05431 7C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

User-Specific Water Demand Elasticities.
W91-05790 6D

Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Solute Rejection in Freezing Soils.
W91-05840 2K

Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

MODEL TESTING

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

MODUMANG PROGRAM

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

MOISTURE

Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

MOISTURE DEFICIENCY

Role of Temperature for Drought Study.
W91-05627 2E

MOISTURE STRESS

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

MOJAVE

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

MOLECULAR STRUCTURE

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

MOLLUSCICIDES

New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

MOLLUSKS

Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

MONITORING

Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

Making Groundwater Safe to Drink.
W91-05034 5G

Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

Can the United States Afford Biomonitoring.
W91-05143 5G

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Continuous Water Quality Monitoring.
W91-05287 5G

Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

MONTE CARLO METHOD

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

MOSCOW

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

MOUNTAIN STREAMS

Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

MOUNTAINS

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

MUD

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

MULTIPHASE FLOW

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

MULTIPURPOSE RESERVOIRS

Hydrostation Reservoirs and Recreation.
W91-05086 8A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

MUNICIPAL WASTES

Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

MUNICIPAL WASTEWATER

Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

MUNICIPAL WATER

What is a Water Audit.
W91-05211 3D

MUNITIONS WASTES

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

MURRAY RIVER BASIN

Optical Properties of Waters in the Murray-Darling Basin, South-Eastern Australia.
W91-05004 2E

MUSSELS

DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

MUTAGENICITY

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

MUTAGENS

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

NAGAREYAMA

Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

NAPHTHALENE

Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

NAPHTHALENES

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

NATURAL GAS

Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

NATURAL WATERS

Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

NAVIGABLE RIVERS

Monitoring River Ice with Landsat Images.
W91-05031 2C

NAVIGATION CHANNELS

Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

NEMATODES

Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

NETWORK DESIGN

Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

Parameter Estimation for Water Distribution Networks.
W91-05794 5F

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

NEUSE RIVER

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

NEUTRON ACTIVATION ANALYSIS

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

NEVADA
Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

NEW BEDFORD HARBOR
Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

NEW BRUNSWICK
Tidal Hydraulics of Saint John River.
W91-05783 2L

NEW HAMPSHIRE
Brief Review of Water Rights in New Hampshire.
W91-05213 6E

N. H. Water Rights: An Endangered Species.
W91-05214 6E

Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

NEW MEXICO
Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

NEW YORK
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

NEW YORK CITY
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

NEW ZEALAND
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

NIGERIA
Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

NIGUA RIVER BASIN
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

NITRATES
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Question of Nitrates.
W91-05904 5B

Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

NITRIFICATION
Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

NITRITES
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

NITROGEN
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

NITROGEN CYCLE
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

NITROGEN REMOVAL
Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

Question of Nitrates.
W91-05904 5B

NITROQUINOLINE
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

NONLINEAR PROGRAMMING
Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

NONPARAMETRIC METHODS
Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

NONPOINT POLLUTION SOURCES
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

NORTH AMERICA

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

NORTH CAROLINA

Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

NORWAY

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

NUCLEAR EXPLOSIONS

Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

NUCLEAR REACTORS

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

NUMERICAL ANALYSIS

Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

NUTRIENT AVAILABILITY

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

NUTRIENT CONCENTRATIONS

Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

NUTRIENT REMOVAL

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

NUTRIENT TRANSPORT

Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

NUTRIENT TRAPPING

Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

NUTRIENTS

Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

OCEAN BOTTOM

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

OCEAN DUMPING

New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

ODOR CONTROL

Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

ODORS

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

OFFSHORE PLATFORMS

Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

OHIO

Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

User-Specific Water Demand Elasticities.
W91-05790 6D

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

OHIO RIVER BASIN

Improving Strategies for Chemical Spills.
W91-05035 5G

OIL

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

OIL INDUSTRY
Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

OIL POLLUTION
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

U.S. Tackles Leaking Tanks.
W91-05070 5G

Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies.
W91-05236 5G

Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

OIL RECOVERY
Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

OIL SPILLS
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

OIL WASTES
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

OIL WELLS
Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

OLIGOCHAETES
Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

OLIGOTROPHIC LAKES
Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

OLMSTED LOCK AND DAM
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

ON-SITE WASTEWATER TREATMENT
Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

ONONDAGA LAKE
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

ONTARIO
Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

OPEN-CHANNEL FLOW
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

OPEN CHANNELS
Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

OPERATING POLICIES
Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

OPTICAL PROPERTIES
Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

Optical Properties of Waters in the Murray-Darling Basin, South-Eastern Australia.
W91-05004 2E

OPTIMIZATION
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

OREGON
Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

ORGANIC CARBON
Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

ORGANIC CHEMICALS
Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

ORGANIC COMPOUNDS
Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

ORGANIC CONDITIONERS
Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

ORGANIC MATTER
Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Biological Removal of Iron from Groundwater.
W91-05751 5F

ORGANIC PESTICIDES
Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

ORGANIC POLLUTANTS
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

ORGANIC SOILS
Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

ORGANIC SOLVENTS
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

ORGANIC WASTES
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

ORGANIZATIONS
What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

ORGANOCHLORINE PESTICIDES
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

ORGANOPHOSPHORUS PESTICIDES
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

ORGANOTIN COMPOUNDS
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

ORTHOPHOSPHATES
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

OSCILLATING FLOW
Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

OUTFALL
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

OUTFALL SEWERS
Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

OVERBURDEN
Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

OXIDATION PONDS
Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

OXIDATION-REDUCTION POTENTIAL
pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

OXISOLS
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

OXYGEN GRADIENTS
Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

OXYGEN ISOTOPES
Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

OXYGEN REQUIREMENTS
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

OXYGEN TRANSFER
Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

OYSTER PONDS
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

OYSTERS
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

OZONATION

Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

OZONE

Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

PACIFIC ISLANDS

Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

PACIFIC OCEAN

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

PALEOHYDROLOGY

Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

PALEOLIMNOLOGY

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

PAMLICO RIVER

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

PARAMETER ESTIMATION

ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

PARTIAL DURATION SERIES

Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

PARTICLE SIZE

Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

PARTICULATE MATTER

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

PASCAGOULA RIVER

Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

PASSAIC RIVER

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

PASTURE MANAGEMENT

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

PASTURES

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

PATH OF POLLUTANTS

Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

PCB Concentrations in Stream Sunfish (Lepomis auritus and L. macrochirus) in Relation to Proximity to Chronic Point Sources.
W91-04982 5B

Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Degradation of Terbacil in Soil.
W91-05226 5B

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies.
W91-05236 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

Miscible Displacement with Density and Viscosity Contrasts. Estimation of Displacement Parameters and Stability in Mechanical Dispersion Regime (Deplacement Miscible Avec Contrastes de Densite et de Viscosite en Milieu Poreux.

Identification des Parametres de Deplacement et Stabilite en Regime de Dispersion Mecanique).
W91-05435 5B

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

PATHOGENIC BACTERIA

Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

PATHS OF POLLUTANTS

Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

PEACE RIVER

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

PEANUTS
Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

PEAT
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

Characteristics of a Marshland Soil Built Up from Marine and Peat Material.
W91-05568 2H

PEAT BOGS
Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

PENNSYLVANIA
Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

PENTACHLOROPHENOL
Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

PEPTIDES
Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

PERCOLATION TESTS
Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

PERFORMANCE EVALUATION
Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

PERIPHYTON
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

PERIYAR RIVER
Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

PERMAFROST
Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

PERMEABILITY
Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

PERSONNEL MANAGEMENT
Measurement of Operator Training Benefits.
W91-05508 5G

PESTICIDE KINETICS
Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

PESTICIDE RESIDUES
Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

PESTICIDE TOXICITY
Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

PESTICIDES
Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

PETROLEUM HYDROCARBONS
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

PETROLEUM PRODUCTS
Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

PHENANTHRENE
Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

PHENOLS
Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

PHOSPHATE
Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

PHOSPHATES
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

PHOSPHORUS
Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

PHOSPHORUS REMOVAL
Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

PHOTOGRAPHY
Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

PHOTOLYSIS
Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

PHOTOSYNTHESIS
Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

PHRAGMITES
Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

PHYSICOCHEMICAL PROPERTIES
Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

PHYSICOCHEMICAL TREATMENT
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

PHYTOPLANKTON
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

PIERS
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

PIGMENTS
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

PILES
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

PILOT PLANTS
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

PINE TREES
Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

PIPES
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

PLANKTON
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

PLANNING
Hydrostation Reservoirs and Recreation.
W91-05086 8A

PLANT GROWTH
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

PLANT GROWTH SUBSTANCES

Production and Stability of Ethylene in Soil.
W91-05337 2G

PLANT PHYSIOLOGY

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

PLANT TOXINS

New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

PLANT-WATER RELATIONSHIPS

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

PLAYAS

Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

PLUG FLOW

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

PLUMBING

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

PLUMES

Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

PLUTONIUM RADIOISOTOPES

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

PODZOLS

Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

POHAKULOA TRAINING AREA

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

POINT-OF-ENTRY WATER TREATMENT

Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Performance and Application of RO Systems.
W91-05707 5F

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

POINT-OF-USE WATER TREATMENT
Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Performance and Application of RO Systems.
W91-05707 5F

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

POISSON RATIO
Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

POLARIZATION
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

POLICY MAKING
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

POLITICAL ASPECTS
Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

POLLUTANT IDENTIFICATION
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

POLLUTANTS
Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

POLLUTION LOAD
Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

POLONIUM RADIOISOTOPES
210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

POLYCHAETES
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

POLYCHLORINATED BIPHENYLS
PCB Concentrations in Stream Sunfish (Lepomis auritus and L. macrochirus) in Relation to Proximity to Chronic Point Sources.
W91-04982 5B

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

POLYCHLORINATED TERPHENYLS
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

POLYCYCLIC AROMATIC HYDROCARBONS
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

POLYELECTROLYTES
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

POLYETHYLENE GLYCOL
Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

POLYMERS
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

PONDING
Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

PONDS
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

POPULATION DENSITY
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

POPULATION DYNAMICS
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

POPULATION EXPOSURE
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

POROSITY
Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

POROUS MEDIA
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

PORTLAND
Portland Water District's Water Distribution Master Plan.
W91-05210 5F

PORTLAND CEMENTS
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

PORTUGAL
Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

POTABLE WATER
Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

Water Supply Challenge in the Gulf Region.
W91-05192 3D

Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

Water Quality for Potable Reuse.
W91-05547 5D

Wilderness Water Purification.
W91-05803 5F

Potable Water Reuse.
W91-05809 5D

POTAMOGETON
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

POTASSIUM
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

POTATOES
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

POTENTIOMETRIC SURFACE
Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

POWERPLANTS
Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

PRECAST CONCRETE
Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

PRECIPITATION
Updating the Smith-Feddes Model.
W91-05277 2B

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

PRECIPITATION INTENSITY
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

PRECIPITATION MAPPING
Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

PRECIPITATION RATE
Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

PRECISION
Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

PREDICTION
Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

PREFERENTIAL FLOW
Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

PRESSURE FILTRATION
Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

PRETREATMENT OF WASTEWATER
Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

PRIMARY PRODUCTIVITY
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

PRINCE WILLIAM SOUND
Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

PROBABILISTIC PROCESS
Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

PROBABLE MAXIMUM PRECIPITATION
Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

PROCEEDINGS
Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

PROCESS CONTROL
Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

PRODUCTIVITY
Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

PROFESSIONAL CERTIFICATION
Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

PROFESSIONAL SOCIETIES
What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

PROJECT PLANNING
Groundwater Remediation Plan.
W91-05033 5G

Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

PROTOZOA
Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

PSEUDOMONAS
Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

PUBLIC HEALTH
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Application of RO Systems.
W91-05707 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

PUBLIC OPINION
Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

PUBLIC PARTICIPATION
Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

PUBLIC POLICY
Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

PUBLIC RELATIONS
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Developing a Risk Communication Strategy.
W91-05020 5F

PUBLIC TRUST DOCTRINE
N. H. Water Rights: An Endangered Species.
W91-05214 6E

PUBLIC UTILITY DISTRICTS
Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

Major Unit Process Evaluation Using the Composite Correction Program Approach.
W91-05811 5D

PUBLIC WATERS
N. H. Water Rights: An Endangered Species.
W91-05214 6E

PUERTO RICO
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

PULP AND PAPER INDUSTRY
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

PULP WASTES
Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

PUMPED STORAGE
Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

PUMPING TESTS
New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

PUMPS
Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

QATAR
Public Attitude Towards Water and Water Reuse.
W91-05546 6B

QUARTZ SENSORS
Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

QUEENSLAND
Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

RADAR
Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

RADIATION
Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

RADIOACTIVE WASTE DISPOSAL
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

RADIOACTIVE WASTES
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

RADIOCHEMICAL ANALYSIS
Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

RADIOISOTOPE CONCENTRATION
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

RADIOISOTOPES
Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

RADIOMETRY
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

RADON
Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

RAIN
Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

RAIN FORESTS
Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

RAIN GAGES
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

RAINFALL
Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

RAINFALL AREA
Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

RAINFALL DISTRIBUTION
Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

RAINFALL FORECASTING
Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

RAINFALL IMPACT
Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

RAINFALL INFILTRATION
Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

RAINFALL RATE
Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

RAINFALL-RUNOFF RELATIONSHIPS
Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

RATING FLUMES
Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

REAL ESTATE
Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

RECEIVING WATERS
Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

RECESSION CURVE
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

RECHARGE
Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

RECLAIMED WATER
International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Ground Water Recharge with Sewage Effluent.
W91-05538 3C

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

Water Quality for Potable Reuse.
W91-05547 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

RECREATION
Hydrostation Reservoirs and Recreation.
W91-05086 8A

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

RECREATION FACILITIES
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

Hydrostation Reservoirs and Recreation.
W91-05086 8A

RECYCLING
Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

DHS Waste Reduction Program.
W91-05670 5G

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

RED RIVER
Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

RED TIDES
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

REEDS
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

REELFOOT LAKE
Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

REEUWIJK LAKES
Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

REFLECTANCE
Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

REFLECTANCE TECHNIQUES
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

REFORESTATION
Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

REGIONAL ANALYSIS
Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

REGIONAL DEVELOPMENT
Water Supply Challenge in the Gulf Region.
W91-05192 3D

REGIONAL FLOODS
Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

REGRESSION ANALYSIS
Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

REGULATIONS
U.S. Tackles Leaking Tanks.
W91-05070 5G

Can the United States Afford Biomonitoring.
W91-05143 5G

Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Translating Research into Practice: The Drinking Water Industry.
W91-05279 5F

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

REINFORCED CONCRETE
Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

REINFORCED SOIL STRUCTURES
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

REMOTE SENSING
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Monitoring River Ice with Landsat Images.
W91-05031 2C

Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

REMOTELY OPERATED VEHICLES
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

RESEARCH FACILITIES
Center for Aquifer Science and Technology (CAST).
W91-05795 9C

RESEARCH PRIORITIES
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Translating Research into Practice: The Drinking Water Industry.
W91-05279 5F

Center for Aquifer Science and Technology (CAST).
W91-05795 9C

Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

RESERVOIR DESIGN
Reservoir Planning for Irrigation District.
W91-05791 6A

RESERVOIR OPERATION
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

RESERVOIR SILTING
Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

RESERVOIR STAGES
Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

RESERVOIRS
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

Hydrostation Reservoirs and Recreation.
W91-05086 8A

Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

RESIDUAL CHLORINE
Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

RESISTIVITY
Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

RESISTIVITY PROFILES
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

RESISTIVITY SURVEYS
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

RESOURCES MANAGEMENT
Environmental Health.
W91-05051 6G

Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

RESPIROMETRY
Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

RETAINING WALLS
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

RETURN FLOW
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

REVERSE OSMOSIS
Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Performance and Application of RO Systems.
W91-05707 5F

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Wilderness Water Purification.
W91-05803 5F

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

REVIEWS
Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

REYNOLDS NUMBER
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

RHENIUM
Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry

with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

RHINE RIVER
Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

RHONE RIVER
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

RIA OF VIGO
Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

RICE
Rice and Furrow Irrigation Management.
W91-05159 3F

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

RIGID FOUNDATIONS
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

RIO GRANDE DE ARECIBO BASIN
Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

RIPARIAN LAND
Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

RIPARIAN RIGHTS
N. H. Water Rights: An Endangered Species.
W91-05214 6E

RIPARIAN VEGETATION
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

RISK ANALYSIS
Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

RISK ASSESSMENT
Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

RISK COMMUNICATION
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Developing a Risk Communication Strategy.
W91-05020 5F

Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

RISK FEEDBACK
Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

RISKS
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Developing a Risk Communication Strategy.
W91-05020 5F

RIVER BEDS
Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

RIVER FORECASTING
Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

RIVER ICE
Monitoring River Ice with Landsat Images.
W91-05031 2C

Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

RIVER MOUTH
Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

RIVER SEDIMENTS
Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

RIVERS
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

ROCK EXCAVATION
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

ROCK MECHANICS
System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

ROCK PROPERTIES
Effect of Dilatancy of Rocks on Resistance to Shearing Loads.
W91-05077 8E

ROCKFILL DAMS
Concrete-Faced Rockfill Dam.
W91-05116 8A

Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

ROLLER-COMPACTED CONCRETES
Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

ROOT DEVELOPMENT
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

ROOT DISTRIBUTION
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

ROOTS
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

ROTATING BIOLOGICAL CONTACTORS
Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

ROUGHNESS COEFFICIENT
Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

RUNOFF
Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

RUNOFF FORECASTING
Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

RURAL AREAS
Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

SAFE DRINKING WATER ACT
Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

SAHEL
Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

SALINE-FRESHWATER INTERFACES
Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

Tidal Hydraulics of Saint John River.
W91-05783 2L

SALINE GROUNDWATER
Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

SALINE LAKES
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

SALINE PONDS
Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

SALINE SOILS
Saline Maritime Soils of Estonia.
W91-05229 2G

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

Solute Rejection in Freezing Soils.
W91-05840 2K

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

SALINE WATER
Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

SALINE WATER INTRUSION
Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

SALINE WATER IRRIGATION
Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

SALINITY
Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

SALINITY

Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

SALMON

Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

SALT MARSHES

Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

SALTON SEA

Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

SALTS

Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

SAMPLE CLEANUP

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

SAMPLE PREPARATION

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

SAMPLE PRESERVATION

Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

SAMPLERS

Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

SAMPLING

Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

SAN ANDRES LAGOON

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

SAN FRANCISCO BAY

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

SAN GERMAN

Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

SAN SALVADOR ISLAND

Water Quality of a Carborate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

SAND

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

SAND AQUIFERS

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

SAND FILTERS

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

SANDS

Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

SANDSTONES

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

SAPROLITES

Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

SATELLITE TECHNOLOGY

Monitoring River Ice with Landsat Images.
W91-05031 2C

Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

SATURATED FLOW

Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

SATURATED SOILS

Production and Stability of Ethylene in Soil.
W91-05337 2G

Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

SAVANNAS

Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

SCANDINAVIA

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

SCENERY

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

SCIENTIFIC PERSONNEL

Center for Aquifer Science and Technology (CAST).
W91-05795 9C

SCOTLAND

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of

Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

SEA BREEZES

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

SEA GRASSES

Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

SEA LEVEL

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

SEA TROUT

Spring Growing Period as a Regulator of the Size of the Smolt Run in Trout (Salmo trutta).
W91-05000 2H

SEA WALLS

Wave Forces on a Wall.
W91-05785 8B

SEALANTS

Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

SEASONAL VARIATION

Spring Growing Period as a Regulator of the Size of the Smolt Run in Trout (Salmo trutta).
W91-05000 2H

Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

Parameter Estimation for Seasonal to Subseasonal Disaggregation.
W91-05431 7C

Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

SEAWATER

Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

SECONDARY WASTEWATER TREATMENT

Water Quality for Potable Reuse.
W91-05547 5D

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

SEDIMENT ANALYSIS

Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

SEDIMENT BAGS

Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

SEDIMENT CHEMISTRY

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

SEDIMENT CONTAMINATION

Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

SEDIMENT CONTROL

Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

Floods Threatening Kashmir Wetlands.
W91-05385 2E

Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

SEDIMENT DISCHARGE

Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

SEDIMENT DISTRIBUTION

Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

SEDIMENT EROSION

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

SEDIMENT LOAD
Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

SEDIMENT SAMPLER
Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

SEDIMENT TRANSPORT
Stability of Free Surface Sediment Flow.
W91-05170 2J

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

Bed Features in Nonuniform Sediments.
W91-05426 2E

Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

SEDIMENT-WATER INTERFACES
Bed Features in Nonuniform Sediments.
W91-05426 2E

Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

SEDIMENTATION
Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

SEDIMENTATION RATES
Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

SEDIMENTS
Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

SEEDLINGS
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

SEEPAGE
Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

SEEPS
Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

SEISMIC PROPERTIES
Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

SEISMIC SURVEYS
Seismic Risk Analysis for Earth Dams.
W91-05868 8A

Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

SEISMOLOGY
Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

SELENIUM
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

SELF POTENTIAL SURVEYS
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

SEMIARID LANDS
International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

SENSITIVITY ANALYSIS
Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

SENSORS
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

SEPARATION TECHNIQUES
Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance

Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

SEPTIC DRAIN FIELDS
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

SEPTIC TANKS
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

SEPTIC WASTEWATER
Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

SEWAGE BACTERIA
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

SEWER SYSTEMS
Heuristic Design of Sewer Networks.
W91-05328 5D

Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

SEWERS
Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

SHALLOW WELLS
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

SHEAR STRESS
Effect of Dilatancy of Rocks on Resistance to Shearing Loads.
W91-05077 8E

SHELLFISH
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

SHELTERBELTS
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

SHORE PROTECTION
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

SHORELINE RETREAT
Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

SILICA
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

SILICATES
Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

SILT
Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

SILTING
Floods Threatening Kashmir Wetlands.
W91-05385 2E

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

SIMULATED RAINFALL
Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

SIMULATION
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

SIMULATION ANALYSIS
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

SITE REMEDIATION
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

Groundwater Remediation Plan.
W91-05033 5G

Making Groundwater Safe to Drink.
W91-05034 5G

Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies.
W91-05236 5G

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

SITE SELECTION
Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

SLAGS
Solids Detoxification: Metals Recovery.
W91-05680 5D

SLOPE EFFECTS
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

SLOPE PROTECTION
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

SLOPE STABILITY
Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

SLOPES
Hillslope Infiltration: Planar Slopes.
W91-05841 2G

SLUDGE
Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

SLUDGE ANALYSIS
Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

SLUDGE BED
Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

SLUDGE CONDITIONING
Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

SLUDGE DEWATERING
Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

SLUDGE DIGESTION
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

SLUDGE DISPOSAL
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

Biodegradation of Land-Applied Sludge.
W91-05392 5E

Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Revival of Incineration in the UK.
W91-05507 5D

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

SLUDGE DRYING
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

SLUDGE FILTERS
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

SLUDGE TREATMENT
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

Revival of Incineration in the UK.
W91-05507 5D

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Solids Detoxification: Metals Recovery.
W91-05680 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Biological Treatment of Mercury Waste.
W91-05692 5D

Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

SLUDGE UTILIZATION

Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

SMALL WATERSHEDS

Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

SMITH-FEDDES MODEL

Updating the Smith-Feddes Model.
W91-05277 2B

SNAG REMOVAL

Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

SNAILS

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

SNOW

Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

SNOW ACCUMULATION

Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

SNOW COVER

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

SNOW SURVEYS

Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

SNOWPACK

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

SOCIAL ASPECTS

Public Attitude Towards Water and Water Reuse.
W91-05546 6B

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

SODIC SOIL

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

SODIC SOILS

Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

SODIUM

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

SODIUM CHLORIDE

Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

SOIL ABSORPTION

Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

SOIL ABSORPTION CAPACITY

Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

SOIL AERATION

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

SOIL AGGREGATES

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

SOIL AMENDMENTS

Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

SOIL ANALYSIS

Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

SOIL BACTERIA

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

SOIL CHEMISTRY

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

Saline Maritime Soils of Estonia.
W91-05229 2G

Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

SOIL COLUMNS

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

SOIL COMPACTION

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

SOIL CONSERVATION

Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

SOIL CONTAMINATION

Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Degradation of Terbacil in Soil.
W91-05226 5B

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Petroleum Contaminated Soils. Volume 2: Remediation Techniques, Environmental Fate, Risk Assessment, Analytical Methodologies.
W91-05236 5G

Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

SOIL CONTAMINATIONO

Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

SOIL DENSITY

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

SOIL DISPOSAL FIELDS

Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

SOIL DYNAMICS

Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

SOIL ENGINEERING

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

SOIL ENVIRONMENT

Production and Stability of Ethylene in Soil.
W91-05337 2G

SOIL EROSION

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

Floods Threatening Kashmir Wetlands.
W91-05385 2E

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

Theoretical Principles of Water Erosion Control on Cropland.
W91-05827 4D

Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

SOIL FORMATION

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

SOIL GASES

Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

SOIL GENESIS

Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

SOIL HORIZONS

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

SOIL MECHANICS

Calculated Prediction of Earth Pressures on Tailwater Tunnels of the Rogun Hydroelectric Station.
W91-05076 8E

Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

SOIL MOISTURE DEFICIENCY

Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

SOIL ORGANIC MATTER

Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

SOIL ORGANISMS

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

SOIL PHYSICAL PROPERTIES
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

SOIL PHYSICS
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

SOIL POROSITY
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

SOIL PROFILE
Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

SOIL PROFILES
Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

SOIL PROPERTIES
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

Soil Controls on Recharge to Aquifers.
W91-05469 2F

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

SOIL RECLAMATION
Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

SOIL SOLUTION
Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

SOIL STABILITY
Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

SOIL STABILIZATION
Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

SOIL STRUCTURE
Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

SOIL SURFACES
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

SOIL TEMPERATURE
Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

SOIL TESTS
Production and Stability of Ethylene in Soil.
W91-05337 2G

Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

SOIL TEXTURE
Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

SOIL TREATMENT

Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

SOIL TYPES

Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

SOIL VAPOR SURVEYS

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

SOIL WATER

Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

Volume Recorder for Lysimeter Waters.
W91-05189 2G

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Degradation of Terbacil in Soil.
W91-05226 5B

Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Saline Maritime Soils of Estonia.
W91-05229 2G

Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

Production and Stability of Ethylene in Soil.
W91-05337 2G

Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

Soil Controls on Recharge to Aquifers.
W91-05469 2F

Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Hillslope Infiltration: Planar Slopes.
W91-05841 2G

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

SOIL WATER

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

SOIL-WATER-PLANT RELATIONSHIPS

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

SOIL WATER POTENTIAL

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

SOIL-WATER RELATIONSHIPS

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

SOILS

Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

SOLAR ENERGY

Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

SOLAR STILLS

Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

SOLID WASTE DISPOSAL

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

SOLID WASTES

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

SOLUBILITY

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

SOLUTE REJECTION

Solute Rejection in Freezing Soils.
W91-05840 2K

SOLUTE TRANSPORT

Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

SORGHUM

Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

SORPTION

Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

SOUTH AFRICA

ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Continuous Water Quality Monitoring.
W91-05287 5G

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

SOUTH AMERICA

Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

SOUTH CAROLINA

Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

SOUTHERN OSCILLATION

Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

SOVIET UNION

Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

Hydrostation Reservoirs and Recreation.
W91-05086 8A

Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

Theoretical Principles of Water Erosion Control on Cropland.
W91-05827 4D

Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

SPAIN

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

SPATIAL DISTRIBUTION

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

SPECIES COMPOSITION

Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

SPECIES DIVERSITY

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

SPECIFIC YIELD

Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

SPECTRAL ANALYSIS

Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

SPECTROMETRY

Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

SPECTROPHOTOMETRY

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

SPECTROSCOPY
Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

SPILLS
Improving Strategies for Chemical Spills.
W91-05035 5G

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

SPIRAL FLOW AERATION
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

SPRUCE TREES
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

SRI LANKA
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

ST CHRISTOPHER AND NEVIS
Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

STABILIZATION PONDS
Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

STAGE-DISCHARGE RELATIONS
Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

STANDARDS
Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

STATE JURISDICTION
Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

STATE REVOLVING FUNDS
ABCs of SRFs.
W91-05071 5D

STATIC PILE COMPOSTING
Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

STATISTICAL ANALYSIS
Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

STATISTICAL METHODS
Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

STATISTICS
Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

STEADY FLOW
Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

STEEL INDUSTRY
Ferrous Foundry Waste Minimization Options.
W91-05677 5G

STEPPES
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

STILLING BASINS
Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

STOCHASTIC MODELS
Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

STOCHASTIC PROCESS
Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

STOMATAL TRANSPIRATION
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

STORAGE TANKS
Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

STORM RUNOFF
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

STORM SEWERS
Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

STORM WATER
Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

STORM WATER MANAGEMENT
Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

STORMS
Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

STRAIN MEASUREMENT
State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

STREAM BANKS
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

STREAM BIOTA
Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

STREAM CHEMISTRY
Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

STREAM CLASSIFICATION
Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

STREAM DISCHARGE
Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

STREAM DISCHARGES
Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

STREAM ECOLOGY
Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

STREAM FISHERIES
Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

STREAM POLLUTION
Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

STREAM USE
Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

STREAMBEDS
Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

STREAMFLOW
Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

Parameter Estimation for Seasonal to Subseasonal Disaggregation.
W91-05431 7C

Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

STREAMFLOW DATA
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

STREAMFLOW FORECASTING
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

STRESS
Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

STRESS ANALYSIS
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

STRONTIUM
Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

STRUCTURAL BEHAVIOR
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

STRUCTURAL ENGINEERING
Reliability of the Assurance of Stability of Earth Masses.
W91-05088 8D

Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

STRUCTURAL GEOLOGY
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

STRUCTURAL STABILITY
Reliability of the Assurance of Stability of Earth Masses.
W91-05088 8D

STRUCTURE-ACTIVITY RELATIONSHIPS
Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

SUBHUMID CLIMATES
Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

SUBLETHAL EFFECTS
Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

SUBSIDENCE
Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

SUBSOIL
Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

SUBSTRATES
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

SUBSURFACE DRAINAGE
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

SUBSURFACE FLOW
Hillslope Infiltration: Planar Slopes.
W91-05841 2G

Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

SUBSURFACE IRRIGATION
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

SUCCESSION
Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

SUDDS
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

SULFATES
Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

SULFUR BACTERIA
Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

SULFUR COMPOUNDS
Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

SULFUR CYCLE
Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

SULFUR DIOXIDE
Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

SUNFISH
PCB Concentrations in Stream Sunfish (Lepomis auritus and L. macrochirus) in Relation to Proximity to Chronic Point Sources.
W91-04982 5B

Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

SUPERCRITICAL FLOW
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

SUPERCRITICAL FLUID EXTRACTION
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

SUPERFUND
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

SURFACE DETENTION
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

SURFACE-GROUNDWATER RELATIONS
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

SURFACE SEALING
Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

SURFACE WATER
Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

SURFACE WATER DATA
Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

SURFACTANTS
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by

1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

SURVEYS
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

Public Attitude Towards Water and Water Reuse.
W91-05546 6B

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

SUSPENDED LOAD
Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

SUSPENDED SEDIMENTS
Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

SUSPENDED SOLIDS
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

SWEDEN
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

SYMPOSIUM
Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

SYNERGISTIC EFFECTS
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

SYNOPTIC ANALYSIS
Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

SYSTEMS ANALYSIS
Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

SYSTEMS ENGINEERING
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

TAIWAN
Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

TANNERY WASTES
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

TECHNICAL SOCIETIES
Center for Aquifer Science and Technology (CAST).
W91-05795 9C

TECHNOLOGY
Substituting Thermal Spraying for Electroplating.
W91-05675 5G

TELEMETRY
Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

TEMPERATURE EFFECTS
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

Role of Temperature for Drought Study.
W91-05627 2E

Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

TEMPORAL DISTRIBUTION
Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

TENNESSEE
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

TENSIOMETERS
Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

TERBACIL
Degradation of Terbacil in Soil.
W91-05226 5B

TESTING PROCEDURES
Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

TEXAS
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

TEXTILE MILL WASTES
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

THAILAND
Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

THE NETHERLANDS
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

THERMOPHILIC BACTERIA
Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

THIN LAYER CHROMATOGRAPHY
New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

THIOSULFATES
Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

THREE-DIMENSIONAL MODELS
Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

THUNDERSTORMS
Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

TIDAL EFFECTS
Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

TIDAL ENERGY
Tidal Hydraulics of Saint John River.
W91-05783 2L

TIDAL FLOODS
Saline Maritime Soils of Estonia.
W91-05229 2G

TIDAL HYDRAULICS
Tidal Hydraulics of Saint John River.
W91-05783 2L

TIDAL RIVERS
Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Tidal Hydraulics of Saint John River.
W91-05783 2L

TILE DRAINAGE
Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

TILEFISH
Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

TILLAGE
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

TILTMETERS
Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

TIME SERIES ANALYSIS
Role of Temperature for Drought Study.
W91-05627 2E

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

TIN
Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

TISSUE ANALYSIS
Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

TOBACCO
Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

TOILETS
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

TOKYO
Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

TOLUENE
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

TOPOGRAPHY
Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

TOXIC WASTES
Can the United States Afford Biomonitoring.
W91-05143 5G

TOXICITY
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

TOXICOLOGY

Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

TRACE ELEMENTS

Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

TRACE METALS

Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

TRACERS

Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

One-Dimensional Tracer Model.
W91-05815 2F

Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

TRAINING

Measurement of Operator Training Benefits.
W91-05508 5G

TRANSIENT ANALYSIS

Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

TRANSITION FLOW

Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

TRANSITION ZONE

Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

TRANSPARENCY

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

TRANSPIRATION
Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

TREES
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

TRIAZINE HERBICIDES
Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

TRICHLOROETHANE
Groundwater Remediation Plan.
W91-05033 5G

TRICHLOROETHYLENE
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

TRICHOROETHYLENE
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

TRICKLE IRRIGATION
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

TRIHALOMETHANES
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

TRITIUM
Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

TROPICAL HYDROLOGY
Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

Role of Temperature for Drought Study.
W91-05627 2E

Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

TROPICAL REGIONS

Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

TUFF

Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

TUNNELS

Calculated Prediction of Earth Pressures on Tailwater Tunnels of the Rogun Hydroelectric Station.
W91-05076 8E

TURBULENCE

Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

TURBULENT FLOW

Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

Supercritical Flow in Smooth Open Channels.
W91-05422 8B

TURF GRASSES

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

TYPHOONS

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

ULTRAFILTRATION

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

ULTRAPURE WATER

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

ULTRASONICS

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

ULTRAVIOLET RADIATION

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

UNCERTAINTY

DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

UNCONFINED AQUIFERS

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

UNDERGROUND STORAGE TANKS

U.S. Tackles Leaking Tanks.
W91-05070 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

Toward Economically Efficient Management of Underground Storage Tanks: A Risk-Based Approach.
W91-05264 5G

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

UNDERGROUND WASTE DISPOSAL

Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

UNGAGED WATERSHEDS

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

UNITED STATES

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

UNSATURATED FLOW

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

Hillslope Infiltration: Planar Slopes.
W91-05841 2G

UNSTEADY FLOW
Stability of Free Surface Sediment Flow.
W91-05170 2J

Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

UPGRADING
Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

URBAN AREAS
Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

URBAN HYDROLOGY
Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

URBAN RUNOFF
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

URBAN WATERSHEDS
Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

URBANIZATION
Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

Impact of Man.
W91-05872 4C

UREAS
Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

USSR
What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

UTILITIES
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

VACUUM DISTILLATION
Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

VACUUM EXTRACTION
Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

VADOSE ZONE
Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

VANADIUM
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

VANTAA RIVER
Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

VAPOR-BUDGET TECHNIQUE
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

VAPOR TRANSPORT
Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

VARIABILITY
Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

VEGETABLE CROPS
Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

VEGETATION
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

VEGETATION EFFECTS
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

VERTICAL DISTRIBUTION
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

VINYL CHLORIDE
Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

VIRGIN ISLANDS (US)
Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

VIRUSES
Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

VOLATILE ORGANIC COMPOUNDS
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

VOLATILIZATION
Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

VOLCANIC ISLANDS
Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

VOLUMETRIC ANALYSIS
Volume Recorder for Lysimeter Waters.
W91-05189 2G

WARNING SYSTEMS
Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

WASHINGTON
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

WASTE DISPOSAL
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

Biodegradation of Land-Applied Sludge.
W91-05392 5E

Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

WASTE MANAGEMENT
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

Revival of Incineration in the UK.
W91-05507 5D

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Biological Treatment for Hazardous Wastes.
W91-05843 5D

WASTE RECOVERY
Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Solids Detoxification: Metals Recovery.
W91-05680 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

WASTE REDUCTION

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

DHS Waste Reduction Program.
W91-05670 5G

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

WASTE STABILIZATION

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

WASTE TREATMENT

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

Solids Detoxification: Metals Recovery.
W91-05680 5D

Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

Biological Treatment of Mercury Waste.
W91-05692 5D

Biological Treatment for Hazardous Wastes.
W91-05843 5D

WASTE UTILIZATION

Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

WASTEWATER

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

WASTEWATER ANALYSIS

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

WASTEWATER DISPOSAL

Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

Ground Water Recharge with Sewage Effluent.
W91-05538 3C

Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

WASTEWATER FACILITIES

Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

Lighting Guide for Wastewater Treatment Facilities.
W91-05029 5D

ABCs of SRFs.
W91-05071 5D

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

Gas Metering at Sewage Purification Works.
W91-05291 5D

Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

Computerised Instrumentation and Control Systems.
W91-05293 7B

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

Measurement of Operator Training Benefits.
W91-05508 5G

Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

Greater Cairo Wastewater Project.
W91-05804 5D

Operational Quality in Wastewater Management.
W91-05806 5D

Major Unit Process Evaluation Using the Composite Correction Program Approach.
W91-05811 5D

Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

WASTEWATER IRRIGATION

Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

WASTEWATER LAGOONS

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

WASTEWATER MANAGEMENT

Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Greater Cairo Wastewater Project.
W91-05804 5D

Operational Quality in Wastewater Management.
W91-05806 5D

Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

Major Unit Process Evaluation Using the Composite Correction Program Approach.
W91-05811 5D

Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

WASTEWATER OUTFALL

Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

WASTEWATER POLLUTION

Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

WASTEWATER REACTORS

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

WASTEWATER RENOVATION

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

WASTEWATER TREATMENT

Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

Lighting Guide for Wastewater Treatment Facilities.
W91-05029 5D

Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

Revival of Incineration in the UK.
W91-05507 5D

Measurement of Operator Training Benefits.
W91-05508 5G

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Water Quality for Potable Reuse.
W91-05547 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

Biological Treatment of Mercury Waste.
W91-05692 5D

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Penetration of Biocides into Biofilm.
W91-05747 5D

Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

Sewage Clarification with Magnetite Particles.
W91-05780 5D

Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

Operational Quality in Wastewater Management.
W91-05806 5D

Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

Major Unit Process Evaluation Using the Composite Correction Program Approach.
W91-05811 5D

Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

Biological Treatment for Hazardous Wastes.
W91-05843 5D

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

WASTEWATER USE

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

WASTEWATER UTILIZATION

Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

WATER ALLOCATION

Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

WATER ANALYSIS

Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

WATER AUDIT

What is a Water Audit.
W91-05211 3D

WATER BIRDS

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

WATER CHEMISTRY

Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

WATER CIRCULATION

Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

WATER CONSERVATION

Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

Water Supply Challenge in the Gulf Region.
W91-05192 3D

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

WATER CONVEYANCE

Parameter Estimation for Water Distribution Networks.
W91-05794 5F

WATER CURRENTS

Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

WATER DEFICIT

Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

Role of Temperature for Drought Study.
W91-05627 2E

WATER DEMAND

Water Supply Challenge in the Gulf Region.
W91-05192 3D

Portland Water District's Water Distribution Master Plan.
W91-05210 5F

User-Specific Water Demand Elasticities.
W91-05790 6D

Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

WATER DEPTH

Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

WATER DISTRIBUTION

Portland Water District's Water Distribution Master Plan.
W91-05210 5F

Parameter Estimation for Water Distribution Networks.
W91-05794 5F

WATER DISTRICTS

Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

WATER EQUIVALENT

Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

WATER HARVESTING

Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

WATER HYACINTH

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

WATER LETTUCE

Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

WATER LEVEL

Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

WATER LEVEL

Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

WATER LEVEL FLUCTUATIONS
Stability of Free Surface Sediment Flow.
W91-05170 2J

WATER LOSS
What is a Water Audit.
W91-05211 3D

WATER MANAGEMENT
Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

WATER METERING
What is a Water Audit.
W91-05211 3D

WATER POLICY
Water Supply Challenge in the Gulf Region.
W91-05192 3D

Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

WATER POLLUTIO TREATMENT
Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

WATER POLLUTION
Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Environmental Health.
W91-05051 6G

WATER POLLUTION CONTROL
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Improving Strategies for Chemical Spills.
W91-05035 5G

Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

Plants Protect Water Bodies.
W91-05087 5G

Can the United States Afford Biomonitoring.
W91-05143 5G

Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

Continuous Water Quality Monitoring.
W91-05287 5G

USEPA Pollution Prevention Research Program.
W91-05669 5G

DHS Waste Reduction Program.
W91-05670 5G

Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

Substituting Thermal Spraying for Electroplating.
W91-05675 5G

Closed Loop Plating System for Waste Minimization.
W91-05676 5G

Ferrous Foundry Waste Minimization Options.
W91-05677 5G

Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

Question of Nitrates.
W91-05904 5B

Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

WATER POLLUTION EFFECTS
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

Question of Nitrates.
W91-05904 5B

Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

WATER POLLUTION PREVENTION

Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

U.S. Tackles Leaking Tanks.
W91-05070 5G

Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Toward Economically Efficient Management of Underground Storage Tanks: A Risk-Based Approach.
W91-05264 5G

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

WATER POLLUTION SOURCES

Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

Environmental Health.
W91-05051 6G

Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

Question of Nitrates.
W91-05904 5B

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

WATER POLLUTION TREATMENT

Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

Making Groundwater Safe to Drink.
W91-05034 5G

Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

Biological Treatment of Mercury Waste.
W91-05692 5D

Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

WATER PRESSURE

Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

WATER PRESSURE SENSORS

Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

WATER QUALITY

Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

Improving Strategies for Chemical Spills.
W91-05035 5G

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Plants Protect Water Bodies.
W91-05087 5G

Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

Chemical Analysis of Irrigation Waters in Bahrain.
W91-05545 3F

Water Quality for Potable Reuse.
W91-05547 5D

Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

Point-of-Use/Entry Treatment of Drinking Water.
W91-05694 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Performance and Application of RO Systems.
W91-05707 5F

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

WATER QUALITY CONTROL

Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

WATER QUALITY MANAGEMENT
Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

USEPA Pollution Prevention Research Program.
W91-05669 5G

Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

Wilderness Water Purification.
W91-05803 5F

Potable Water Reuse.
W91-05809 5D

Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

WATER QUALITY MONITORING
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

Computerised Instrumentation and Control Systems.
W91-05293 7B

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

WATER QUALITY STANDARDS
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

Can the United States Afford Biomonitoring.
W91-05143 5G

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

WATER RATES
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

WATER REPELLENT SOILS
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

WATER REQUIREMENTS
Portland Water District's Water Distribution Master Plan.
W91-05210 5F

WATER RESOURCES
Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

WATER RESOURCES DATA
Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

WATER RESOURCES DEVELOPMENT
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

Tropical Hydrology and Caribbean Water Resources.
W91-05611 2A

Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

Impact of Man.
W91-05872 4C

WATER RESOURCES MANAGEMENT
Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

New State Geologic Map for Mississippi: A Tool for Updating Nomenclature and Definitions of the State's Aquifers and Aquitards.
W91-05158 7C

Water Supply Challenge in the Gulf Region.
W91-05192 3D

International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Reservoir Planning for Irrigation District.
W91-05791 6A

Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Climate Change, Hydrology, and Water Resources.
W91-05799 2A

Potable Water Reuse.
W91-05809 5D

Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

WATER REUSE
Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Ground Water Recharge with Sewage Effluent.
W91-05538 3C

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

Public Attitude Towards Water and Water Reuse.
W91-05546 6B

Water Quality for Potable Reuse.
W91-05547 5D

Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

Japan's Aqua Renaissance 90 Project.
W91-05766 5D

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

Potable Water Reuse.
W91-05809 5D

WATER RIGHTS

Brief Review of Water Rights in New Hampshire.
W91-05213 6E

WATER SAMPLING

Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

Continuous Water Quality Monitoring.
W91-05287 5G

Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

WATER SHORTAGE

Water Supply Challenge in the Gulf Region.
W91-05192 3D

WATER SOFTENING

Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

WATER SOURCES

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

WATER STORAGE

Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

WATER STRESS

Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

WATER SUPPLY

Proceedings, Twentieth Mississippi Water Resources Conference, 1990.
W91-05137 2E

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

Public Attitude Towards Water and Water Reuse.
W91-05546 6B

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

WATER SUPPLY DEVELOPMENT

Potable Water Reuse.
W91-05809 5D

WATER TABLE

Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

WATER TABLE FLUCTUATIONS

Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

WATER TABLE RISE

Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

WATER TANKS

Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

WATER TREATMENT

Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

Developing a Risk Communication Strategy.
W91-05020 5F

Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

Use of Chloramines - Past, Present and Future.
W91-05212 5F

Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

Point-of-Use/Entry Treatment of Drinking Water.
W91-05694 5F

Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

Regulation of Water Treatment Devices in California.
W91-05698 5F

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

Performance and Application of RO Systems.
W91-05707 5F

Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

Florida's Funding for Contamination Correction.
W91-05716 5F

Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

Biological Removal of Iron from Groundwater.
W91-05751 5F

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

Wilderness Water Purification.
W91-05803 5F

Potable Water Reuse.
W91-05809 5D

Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

WATER TREATMENT FACILITIES

Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

ICA Symposium on Instrumentation, Control and Automation in Water and Wastewater Management.
W91-05281 5D

Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

Point-of-Use/Entry Treatment of Drinking Water.
W91-05694 5F

WATER USE

Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

WATER USERS
User-Specific Water Demand Elasticities.
W91-05790 6D

WATER VAPOR
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

WATER YIELD
Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

WATERLOGGING
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

WATERSHED MANAGEMENT
Plants Protect Water Bodies.
W91-05087 5G

Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

Annual Runoff Estimation for Catchments in India.
W91-05786 2E

Climatic Sensitivity of California Water Resources.
W91-05793 6B

Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

WATERSHEDS
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

WAVE ACTION
Wave Forces on a Wall.
W91-05785 8B

WAVES
Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

WEATHER DATA COLLECTIONS
Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

WEATHER FORECASTING
Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

WEATHER MODIFICATION
Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

WEATHER PATTERNS
Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

WEATHERING
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

WELL PUMPING
Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

WELL REGULATIONS
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

WELLHEAD PROTECTION
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

WELLS
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

WEST AFRICA
Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

WEST VIRGINIA
Anchoring a Dam.
W91-05069 8A

Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

WET DEPOSITION
Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

WETLAND TREATMENT
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

WETLANDS
Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

Floods Threatening Kashmir Wetlands.
W91-05385 2E

Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

WETTING
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

WHEAT
Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

WILDLIFE HABITATS
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

Floods Threatening Kashmir Wetlands.
W91-05385 2E

WIND EFFECTS
Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

WISCONSIN
Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

WOOD PRESERVATIVES
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

WOOD WASTES
Biotechnology Approach to Bioremediation.
W91-05144 5G

Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

WOODY DEBRIS
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

WYOMING
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

X-RAY SPECTROSCOPY
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

XYLENES
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

YAZOO RIVER
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

YEASTS
Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

YELLOW RIVER
Stability of Free Surface Sediment Flow.
W91-05170 2J

YUCATAN PENINSULA
Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

ZEOLITE
Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

ZINC
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

ZIRCONIUM
Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

ZOOPLANKTON
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

AUTHOR INDEX

ABBASSI, B.
Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

ABDULMUMIN, S.
Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

ABE, H.
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

ABE, T.
Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

ABERG, G.
Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

ABOH, I.
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

ABRISHAMCHI, A.
Reservoir Planning for Irrigation District.
W91-05791 6A

ABT, S. R.
Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

ABUZEID, N. S.
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

ACHIK, J.
Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

ADAMS KSZOS, L.
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

ADEJUWON, J. O.
Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

ADEJUWON, S. A.
Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

ADMIRAAL, W.
Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

AFSHAR, A.
Reservoir Planning for Irrigation District.
W91-05791 6A

AGAMI, M.
Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

AGOSIN, E.
Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

AGUILERA, G.
Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

AHARON, P.
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

AHMAD, S.
Public Attitude Towards Water and Water Reuse.
W91-05546 6B

AHN, K. H.
Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

AHOLA, H.
Vegetated Buffer Zone Examinations on the Vantaa River Basin.
W91-05065 4D

AHRING, B. K.
Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

AITKEN, R. L.
Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

AIVAZOV, B. Y.
Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

AIZAKI, M.
Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

AIZAWA, J.
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

AJAO, E. A.
Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

AKHMEDOV, G. M.
Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

AKHTER, M. S.
Chemical Analysis of Irrigation Waters in Bahrain.
W91-05545 3F

AL-ABED, S. R.
Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

AL-BADER, B.
Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

AL-DAHER, R.
Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

AL-LAYLA, R. I.
Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

AL-SABTI, K.
Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

AL-SANAD, H.
Laboratory Study on Leaching of Calcareous Soil from Kuwait.
W91-05378 2G

ALAM, J.
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

ALBAIGES, J.
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

ALBARET, J.-J.
Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

ALBERTS, J. J.
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

ALBINO, M.
Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

ALCANIZ, J. M.
Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

ALDENBERG, T.
Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

ALEXANDER, M.
Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

ALHAJJAR, B. J.
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

ALLEN, H. H.
Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

ALLEN, R. C.
Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

ALLILUEVA, E. I.
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

ALLSOP, P. J.
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

ALONGI, D. M.
Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associat-

ALONGI, D. M.

ed with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

ALPERT, P.
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

ALVA, A. K.
Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

ALVAREZ, A. J.
Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

AMAR, D.
Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

AMAYA, F.
Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

AMBLARD, C.
Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

AMOOZEGAR, A.
Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

AMRHEIN, C.
Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

AMUNDSON, P. G.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

AMY, P. S.
Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

ANAMOSA, P. R.
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

ANANTHALAKSHMIKUMARI, K. V. V.
Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

ANDERSON, A. C.
New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

ANDERSON, B. S.
Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

ANDERSON, G. A.
Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

ANDERSON, S. H.
Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

ANDERSON, W. B.
Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

ANDERSSON, P.
Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

ANDRAS, E.
Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

ANDREINI, M. S.
Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

ANDREONI, V.
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

ANDREU-MOLINER, E.
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

ANGLE, J. S.
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

ANKLEY, G. T.
Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

ANNE, D. C.
Meaningful Environmental Data: Not Just the Laboratory's Responsibility.
W91-05410 7B

ANTHONY, S. J.
Techniques for Appraisal of Ground-Water Resources on Atoll Islands: Case Studies from Micronesia.
W91-05640 2F

ANTISARI, L. V.
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

ANTROPOVSKII, V. I.
Calculation of the Controlling Depths of Deformable River Channels.
W91-05315 2J

ANTWI, L. A.
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

AOKI, M.
Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

AOKI, N.
Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

AOKI, T.
Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

APONTE, F. I.
Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

APPELO, C. A. J.
Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

ARAMBURO, B.
Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

ARAR, A.
Wastewater Reuse for Irrigation in the Near East Region.
W91-05541 3C

ARAVENA, R.
Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

ARIENZO, M.
Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

ARIPOV, N. F.
Soft Clay Soils in the Foundation of Hydraulic Structures.
W91-05305 8D

ARMSTRONG, A. C.
Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

ARMSTRONG, R.
'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

ARROYO, I. E.
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

ARSHAD, M.
Production and Stability of Ethylene in Soil.
W91-05337 2G

ARTEMI, F.
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

ARTIOLA, J. F.
Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

ARTS, G. H. P.
Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

ARVIN, E.
Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

ARVOLA, L.
Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

ASANO, T.
Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

ASBURY, C. E.
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

ASCHMANN, S. G.
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

ASHER, C. J.
Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

ASMUSSEN, L. E.
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

ASOKAN, P. K.
Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

ASSEL, R. A.
Ice-Cover Climatology for Lake Erie and Lake Superior for the Winter Seasons 1897-1898 to 1982-1983.
W91-05371 2C

ATANASOFF, K.
Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

ATLAS, D.
Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

AUBERT, M.
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

AULENBACH, D. B.
Center for Aquifer Science and Technology (CAST).
W91-05795 9C

AYA, H.
Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

AZOV, Y.
Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

BACK, W.
Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

BACKHUS, D. A.
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

BADIANI, M.
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

BAETZ, B.
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

BAIER, U.
Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

BAILEY, B. J.
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

BAINES, G. B. K.
Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

BAIRD, D. J.
Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

BAJWA, M. S.
Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

BALCERZAK, W.
Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

BALDWIN, P. L.
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

BALEBONA, M. C.
Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

BALES, R. C.
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

BALL, L. M.
Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

BALLESTRA, S.
Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

BALOGUN, E. E.
Annual and Seasonal Patterns of Rainfall Fluctuations in Sub-Saharan West Africa.
W91-05376 2B

BAMBER, R. N.
Effects of Acidic Seawater on Three Species of Lamellibranch Mollusc.
W91-05055 5C

BAMFORD, S. A.
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

BANAT, I.
Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

BANG, A.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

BANKS, P. A.
Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

BANNINK, M. H.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

BANWART, W. L.
Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

BAR-TAL, A.
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

BARANOVA, T. E.
Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

BARBER, I.
Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

BARDOSSY, A.
Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

BARIAC, T.
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

BARKACH, J.
Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

BARKO, J. W.
Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

BARLOCHER, F.
Factors that Delay Colonization of Fresh Alder Leaves by Aquatic Hyphomycetes.
W91-04995 2H

BARMUTA, L. A.
Interaction Between the Effects of Substratum, Velocity and Location on Stream Benthos: an Experiment.
W91-05003 2E

BARNARD, J. L.
Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

BARNES, D.
Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

BARNETT-MOORE, J. A.
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

BARR, A. G.
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

BARRON, R. J.
Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

BARRS, H. D.
Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

BARTHA, R.
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

BARTLETT, D. S.
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

BARTLETT, K. B.
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

BARTONE, C. R.
International Perspective on Water Resources Management and Wastewater Reuse--Appropriate Technologies.
W91-05532 3C

BARTONOVA, A.
Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

BASHKIN, V. N.
Biogeochemistry of Nitrogen in Agricultural Landscapes.
W91-05349 2G

BASILE, G.
Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

BASNET, C.
Parameter Estimation for Water Distribution Networks.
W91-05794 5F

BATEL, R.
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

BAUDIN, J. P.
Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

BAUDU, M.
Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

BAUMAN, B.
Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

BAYKAL, B. B.
Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

BAYNE, C. K.
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

BEACH, A.
Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

BEAUMAN, W. H.
Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

BECK, J. N.
Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

BECK, M. B.
Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

BEEKMAN, H. E.
Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

BEER, S.
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

BELANGER, T. V.
Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

BELCHER, W. R.
Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

BELL, C. E.
State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

BELLAR, T. A.
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

BELLEN, G. E.
Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

BELLUCK, D. A.
Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

BELTRAN, F. J.
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

BELTRANDO, G.
Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

BENDER, D.
Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

BENDER, P. A.
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

BENITEZ, J.
Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

BENJAMIN, S. L.
Risk Feedback: An Important Step in Risk Communication.
W91-05021 5F

BENSON, C. H.
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

BENSON, R. L.
On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

BENSON, W. H.
Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

BERDICHEVSKII, G. Y.
Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

BERGERON, L.
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

BERGSTROM, L.
Leaching of Chlorsulfuron and Metsulfuron Methyl in Three Swedish Soils Measured in Field Lysimeters.
W91-05401 5B

Use of Lysimeters to Estimate Leaching of Pesticides in Agricultural Soils.
W91-05389 7B

BERN, C. M.
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

BETSCHER, L. H.
Improving Strategies for Chemical Spills.
W91-05035 5G

BEVEN, K. J.
Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

BHENDE, S.
Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

BIANCHIN, S. L.
Point-of-Use and Point-of-Entry Treatment Devices Used at Superfund Sites to Remediate Contaminated Drinking Water.
W91-05718 5F

BICKELHAUPT, D. H.
Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

BICUDO, J. R.
Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

BIEHL, F. J.
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

BIERKENS, J.
Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

BIHARI, N.
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

BILEV, E. A.
Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

BILLA, M. E.
Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

BINEY, C. A.
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

BINGHAM, G. E.
Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

BINKLEY, J. S.
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

BISCAYE, P.
Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

BISHAI, H. M.
Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

BISHOP, S. L.
Portland Water District's Water Distribution Master Plan.
W91-05210 5F

BLAIKIE, S. J.
Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

BLAISDELL, M.
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

BLANCK, H.
Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

BLANCO, P.
Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

BLAND, W. L.
Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

BLASCO, J.
Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

BLASI, P.
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

BLATTNER, R. A.
ABCs of SRFs.
W91-05071 5D

BLEVINS, R. D.
Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

BLEVINS, R. L.
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

BLISS, P. J.
Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

BLOH, K.
Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

BLOOM, R. A.
Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

BLUE, W. G.
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

BLUM, A.
Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

BLUM, D. J. W.
Comparison of Serum Bottle Toxicity [illegible] with OECD Method.
W91-05322 5D

BOBRIKOVA, Y. T.
Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

BOETTCHER, B.
Biological Removal of Iron from Groundwater.
W91-05751 5F

BOEVE, L.
Removing Petroleum Products from Soils with Ozone, Ultraviolet, Ultrasonics, and Ultrapure Water.
W91-05258 5G

BOGARDI, I.
Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

BOGARDI, J. J.
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

BOLENDER, S. L.
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

BOMBI, G. G.
Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

BOND, A. M.
Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

BONELL, M.
International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

BONFANTI, P.
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

BONGERS, T.
Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

BONTOUX, J.
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

BOOKER, N. A.
Sewage Clarification with Magnetite Particles.
W91-05780 5D

BORAZJANI, A.
Biotechnology Approach to Bioremediation.
W91-05144 5G

BORAZJANI, H.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

BORLAKOGLU, J. T.
Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

BOROVINSKAYA, L. B.
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

BORREGA, J. J.
Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

BOSCARDIN, M. D.
Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

BOUAZIZ, A.
Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

BOUCHARD, R. J.
Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

BOUCLIN, G.
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

BOUDOU, A.
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

BOUMA, J.
Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

BOURDIER, G.
Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

BOURGADE, L.
Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

BOUWER, H.
Ground Water Recharge with Sewage Effluent.
W91-05538 3C

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

BOWEN, G. E.
Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

BOWERS, A. R.
Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

BOWES, G.
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

BOWLING, J. W.
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

BOYER, T. K.
Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

BOYLE, M.
Biodegradation of Land-Applied Sludge.
W91-05392 5E

BOZZELLI, J. W.
Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

BRADBURY, S. P.
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

BRADFORD, J. M.
Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

BRAGG, R. A.
Anchoring a Dam.
W91-05069 8A

BRANNON, J. M.
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

BRAUN, R.
Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

BRAY, D. T.
Performance and Application of RO Systems.
W91-05707 5F

BREA, J.
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

BRINSON, M. M.
Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

BRISBIN, I. L.
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

BRIX, H.
Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

BROCARD, D.
Making Groundwater Safe to Drink.
W91-05034 5G

BROCK, C. A.
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

BRODERICK, G. P.
Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

BRODERIUS, S. J.
Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

BRONSHTEIN, V. I.
Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

BROOKS, C. M.
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

BROOKS, J. M.
Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

BROWN, B.
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

BROWN, K. W.
Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

BROWN, L. C.
DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

BROWN, M. A.
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

BROWN, P. A.
Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

BROWNING, J. S.
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

BRUCKLER, L.
Modeling Wheat Seedling Growth and Emergence: I. Seedling Growth Affected by Soil Water Potential.
W91-05607 2G

Modeling Wheat Seedling Growth and Emergence: II. Comparison with Field Experiments.
W91-05608 2I

BRUNNER, C. M.
Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

BRUSSEAU, M. L.
Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

BRYAN, G. W.
Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

BUCHANAN, P.
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

BUCHHOLZ, W. J.
Greater Cairo Wastewater Project.
W91-05804 5D

BUDDE, W. L.
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

BUDDEMEIER, R. W.
Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

BUES, M. A.
Miscible Displacement with Density and Viscosity Contrasts. Estimation of Displacement Parameters and Stability in Mechanical Dispersion Regime (Deplacement Miscible Avec Contrastes de Densite et de Viscosite en Milieu Poreux. Identification des Parametres de Deplacement et Stabilite en Regime de Dispersion Mecanique).
W91-05435 5B

BUFFONE, R.
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

BUISHAND, T. A.
Bias and Variance of Quantile Estimates from a Partial Duration Series.
W91-05429 7C

BUKHARTSEV, V. N.
Reliability of the Assurance of Stability of Earth Masses.
W91-05088 8D

BURGESS, T. L.
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

BURGHER, B. J.
Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

BURGOS, C. N.
Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

BURLAKOV, V. N.
Effect of Dilatancy of Rocks on Resistance to Shearing Loads.
W91-05077 8E

BURNS, J.C.
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

BURNS, R. F.
Regulation of Water Treatment Devices in California.
W91-05698 5F

BURRIDGE, L. E.
Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

BURRIS, D. R.
Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

BURT, G. R.
Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

BURT, P.
Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

BUSHNAK, A. D.
Water Supply Challenge in the Gulf Region.
W91-05192 3D

BUTCHER, J. B.
Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

BUTLER, E. C. V.
Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

BUXTON, H. T.
Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

BYSZEWSKI, C. H.
Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

CABON, J. Y.
Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

CADET, D.
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

CAIRNS, J.
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

CAIRNS, S. C.
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

CALABRESE, E. J.
Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

CALABRO, V.
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

CALLAHAN, M.
Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

CALLENDER, W. R.
Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

CALMET, D.
Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

CALOW, P.
Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: I. Chronic Life-History Effects.
W91-05042 5C

Clonal Variation in General Responses of Daphnia magna Straus to Toxic Stress: II. Physiological Effects.
W91-05043 5C

CAMARGO, J. A.
Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

CAMERON, D. M.
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

CAMFIELD, F. E.
Wave Forces on a Wall.
W91-05785 8B

CAMP, J.
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

CAMPANELLA, R. G.
Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

CAMPBELL, M. D.
Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

CANTERAS, J. C.
Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

CAPANNESI, G.
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

CARACO, N. F.
Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

CARBERRY, J. B.
Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
W91-05764 5D

CARBONNEL, J. P.
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

CARLETON, A. M.
Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

CARNEY, R.
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

CARPENTER, C. L.
Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

CARPENTER, D. A.
Mechanisms of Interannual Variability of the Southwest United States Summer Rainfall Maximum.
W91-05412 2B

CARRASQUILLO, R. A.
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

CARTWRIGHT, P. S.
Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

CASANA, J.
Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

CASELLAS, C.
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

CASIANO, V. L.
Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

CASTRO,
Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

CASWELL, M.
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

CAUWET, G.
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

CAVIEDES, C. N.
Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

CAYLESS, S. M.
Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

CEBRIAN, C.
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

CECCHI, A.
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

CELANO, G.
Absorption of Herbicides by Soils of the Campania Region (Adsorbimento di Diserbanti su Suoli della Campania).
W91-05482 5B

CERDA, V.
Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

CHAIZE, S.
Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

CHAMPEAU, T. R.
Ichthyofaunal Evaluation of the Peace River, Florida.
W91-05411 5C

CHANDRA, P.
Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

CHANDRAMOHAN, D.
Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

CHANG, B. K. L.
Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

CHANG, H. T.
Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

CHANG, J. S.
Performance Evaluation of Compact RBC-Settling Tank System.
W91-05754 5D

CHANG, L. A.
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

CHANG, M.
Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

CHANG, T.
Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

CHANG, T. J.
Role of Temperature for Drought Study.
W91-05627 2E

CHANSANG, H.
Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

CHANTLER, R. A.
Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

CHAPUIS, R. P.
Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

CHARALAMBOUS, C.
Heuristic Design of Sewer Networks.
W91-05328 5D

CHARBENEAU, R. J.
Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

CHARRIERE, B.
Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

CHASSEFIERE, B.
Mass-Physical Properties of Surficial Sediments on the Rhone Continental Margin: Implications for the Nepheloid Benthic Layer.
W91-05451 2J

CHEMBURKAR, A.
Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

CHEN, S. K.
Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

CHENG, S.
Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

CHENG, S. S.
Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

CHERKAUER, D. S.
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

CHERRY, J. A.
Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

CHERRY, R. D.
210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

CHESTER, A. J.
Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

CHESTERS, G.
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

CHEUNG, V.
Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

CHI, C. T.
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

CHIEW, R. F.
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

CHIEW, Y. M.
Bed Features in Nonuniform Sediments.
W91-05426 2E

CHILTON, P. J.
Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

CHIN, K. K.
Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

CHIRNSIDE, A. E. M.
Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

CHO, H. J.
Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

CHOHJI, T.
Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

CHOI, E.
Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

CHOPART, J. L.
Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

CHOQUETTE, A. F.
Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

CHOUDHURY, G. S.
Biological Treatment of Mercury Waste.
W91-05692 5D

CHRISTAN, E.
Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

CHRISTMAN, R. F.
Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

CHUANG, Y.
Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

CIAVATTI, C.
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

CIBIK, S. J.
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

CID MONTANES, J. F.
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

CLARK, E. A.
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

CLARK, R. M.
Translating Research into Practice: The Drinking Water Industry.
W91-05279 5F

CLARK, S. W.
Point-of-Entry and Point-of-Use Devices for Meeting Drinking Water Standards.
W91-05695 5F

CLARKSON, C. R.
Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

CLEASBY, J. L.
Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

CLEMMENS, A. J.
Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

CLEVELAND, T. G.
Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

COGLEY, S. R.
Major Unit Process Evaluation Using the Composite Correction Program Approach.
W91-05811 5D

COLE, J. J.
Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

COLE, L.
Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

COLELLA, C.
Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

COLLINS, R. A.
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

COLLOS, Y.
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

COLOGNOLA, M.
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

COLVIN, R. J.
Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

COMA, J.
Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

COMPTON, B. L.
Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

CONLON, W. J.
Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

CONTRACTOR, D. N.
Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

COOEY, J.
Interaction Between Yazoo River and Mississippi River Valley Alluvial Aquifer System.
W91-05152 2F

COOKE, J. B.
Concrete-Faced Rockfill Dam.
W91-05116 8A

COOPER, C. M.
Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

COOPER, J. D.
Soil Controls on Recharge to Aquifers.
W91-05469 2F

CORALLINE, K.
Wilderness Water Purification.
W91-05803 5F

CORAPCIOGLU, M. O.
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

CORAPCIOGLU, M. Y.
Solute Rejection in Freezing Soils.
W91-05840 2K

CORNAX, R.
Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

CORREA, I. E.
Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

CORTESI, P.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

COSBY, B. J.
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

COSTA, P.
Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

COUILLARD, D.
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

COULET, P. R.
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

COULOMBE, R. A.
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

COULON, A. R.
Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

COUTURE, P.
Effects of a Pulp and Paper Mill Effluent on the Structure and Metabolism of Periphytic Algae in Experimental Streams.
W91-05335 5C

COVICH, A. P.
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

COWGILL, U. M.
History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

CRANE, A.
Recovery of Metals in Circuit Board and Metal Plating Manufacturing.
W91-05682 5D

CRAWFORD, J. L.
Potentiometric Surface of the Mississippi River Valley Alluvial Aquifer, 1981-1989.
W91-05155 2F

CRIPPS, A. C.
Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

CROCKER, T. D.
Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

CROWIE, I. D.
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

CROWL, T. A.
Effects of Hurricane Storm Flow on Transport of Woody Debris in a Rain Forest Stream (Luquillo Experimental Forest, Puerto Rico).
W91-05631 2J

CRUZ-AROCHO, M.
Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

CRUZADO, A.
Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

CUONG, H. D.
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

CURRIE, R. G.
Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

CURRY, J. A.
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

CZAPAR, G. F.
Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

CZARNECKI, R. C.
Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

D'ANGELO, E.
Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

D'URSO, E. M.
Phosphate-Sensitive Enzyme Electrode: A Potential Sensor for Environmental Control.
W91-05090 7B

DA MOTTA-MARQUES, D. M. L.
Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

DAFFONCHIO, D.
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

DANA, I. N.
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

DANCER, B. N.
Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

DANIEL, D. E.
Stabilizing Compacted Clay Against Chemical Attack.
W91-05128 8D

Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

DANIEL, F. B.
Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

DANIELS, D. P.
Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

DARAB, K.
Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

DATTA, B.
Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

DAUGHERTY, S. J.
California Leaking Underground Fuel Tank Field Manual: A Guidance Document for Assessment of Underground Fuel Leaks.
W91-05265 5G

DAVILA, S. I.
Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

DAVIS, J. W.
Aerobic Biodegradation of Vinyl Chloride in Groundwater Samples.
W91-05098 5B

DAVIS, R. E.
Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

DAVIS, T. S.
ABCs of SRFs.
W91-05071 5D

DAVIS, W. F.
Case Study of Lead in Drinking Water: Protocol, Methods, and Investigative Techniques.
W91-05089 5B

DAWSEY, W. J.
Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

DAY, A. W.
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

DAY, K. E.
Pesticide Residues in Freshwater and Marine Zooplankton: A Review.
W91-05113 5B

DE BEER, R.
Demineralisation Effluent Purification by Vacuum Distillation.
W91-05295 5D

DE BIASI, M. G.
Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

DE LAPPE, B. W.
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

DE LEEUW, F. A. A. M.
Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

DE LYON, M. J. H.
Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

DE MADRON, X. D.
Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

DE MARSILY, G.
Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

DE RUYTER VAN STEVENINCK, E. D.
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

DE SOUZA SIERRA, M. M.
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

DE STEIGUER, J. E.
Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

DE ZWAAN, A.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

DE ZWART, D.
Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

DECELL, T.
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

DEEGAN, L. A.
Effects of Estuarine Environmental Conditions on Population Dynamics of Young-of-the-Year Gulf Menhaden.
W91-05595 2L

DEL PANNO, M. T.
Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

DELAUNE, R. D.
Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

DELGADO, D.
Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

DELGADO, M.
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

DELHAIZE, E.
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

DELMAS, D.
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

DEMALACH, Y.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

DEMCHENKO, Y. I.
Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

DEMIN, V. V.
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

DERYUGIN, L. M.
Low-Clinker Cement for Hydraulic Structures.
W91-05079 8F

DES MARAIS, D. J.
Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

DHIMAN, N. K.
Evaluation of Optimum Thickness of Bottom Insulation for a Conventional Solar Still.
W91-05197 3A

DHULDHOYA, N.
Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

DI LENA, G.
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

DIAZ, L. F.
Biological Treatment for Hazardous Wastes.
W91-05843 5D

DIBB, J. E.
Beryllium-7 and Lead-210 in the Atmosphere and Surface Snow over the Greenland Ice Sheet in the Summer of 1989.
W91-05864 2K

DICKSON, E. J.
Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

DIERSING, V. E.
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

DILS, R. R.
Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

DIPPENAAR, A. J.
Automation of the Water Supply Scheme on the OFS Goldfields.
W91-05285 5F

DISKIN, M. H.
Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

DIXON, G.
Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

DIYAMANDOGLU, V.
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

DOCKERY, D. T.
New State Geologic Map for Mississippi: A Tool for Updating Nomenclature and Definitions of the State's Aquifers and Aquitards.
W91-05158 7C

DODS, D.
Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

DOEL, D. S.
Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

DOERR, S. M.
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

DOLD, P. L.
Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

DOMINGUEZ, J.
Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

DONARD, O.
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

DOUGHERTY, R. A.
NSF's Listing Program for POU/POE DWTUs.
W91-05703 5F

DOUGLAS, R.
Regulatory Requirements for Point-of-Use Systems.
W91-05696 5F

DOWLE, K.
Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

DOWLING, J. J.
Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

DRAGUN, J.
Three Common Misconceptions Concerning the Fate and Cleanup of Petroleum Products in Soil and Groundwater.
W91-05249 5B

DRIOLI, E.
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

DROSTE, R. L.
Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

DU PREEZ, C. C.
Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

DUFOUR, A. P.
Health Studies of Aerobic Heterotrophic Bacteria Colonizing Granular Activated Carbon Systems.
W91-05711 5F

DUGAS, W. A.
Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

DUNCAN, R. R.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

DUNN, G. H.
Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

DUQUETTE, M.
Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

DURKEE, P. A.
Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

DYKES, G.
Florida's Funding for Contamination Correction.
W91-05716 5F

DYKES, R. S.
Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

DYKOVA, L. M.
Degradation of Terbacil in Soil.
W91-05226 5B

EASTHAM, J.
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

EBERT, E. E.
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

ECKER, F.-J.
Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

ECOUTIN, J.-M.
Influence of the Seasons and Climatic Variations on the Fish Populations of a Tropical Lagoon in West Africa, (Influence des saisons et des variations climatiques sur les peuplements de poissons d'une lagune tropicale en Afrique de l'Ouest).
W91-05160 2L

EDDY, F. B.
Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

EDLING, R. J.
Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

EDWARDS, D. A.
Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

EDWARDS, D. G.
Effect of Solution pH, External Calcium Concentration, and Aluminum Activity on Nodulation and Early Growth of Cowpea.
W91-05495 2I

EDWARDS, W. M.
Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

EFFLER, S. W.
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

EICHELBERGER, J. W.
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

EICHELSDORFER, D.
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

EICK, M. J.
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

EK, M.
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

EL-EHWANY, M.
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

EL HALOUANI, H.
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

ELAKHOVSKII, S. B.
Hydrostation Reservoirs and Recreation.
W91-05086 8A

ELGAMAL, A. M.
La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

ELIMAM, A. A.
Heuristic Design of Sewer Networks.
W91-05328 5D

ELLERY, K.
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

ELLERY, W. N.
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

ELLING, D.
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

ELMALEH, S.
Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

ELMORE, D.
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

ELRICK, D. E.
Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

ELS, H. J.
Computerised Instrumentation and Control Systems.
W91-05293 7B

ELSEEWI, A. A.
Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

EMERY, D.
Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

ENCINAR, J. M.
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

ENGLANDE, A. J.
New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Mollusciciding.
W91-05468 7B

ENGLISH, M. C.
Volume Recorder for Lysimeter Waters.
W91-05189 2G

ENRIGHT, C.
Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

ERIKSSON, K. L.
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

ESEN, I. I.
Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

ESSERY, C. I.
Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

ESSINGTON, E. H.
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

ESTELA, J. M.
Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

ESTRADA, M.
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

EUBANKS, M. J.
Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

EVANS, D. D.
Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

EVERTS, C. J.
Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

EWALD, M.
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

FAGADE, S. O.
Ecology of Neritina glabrata in Lagos Lagoon, Nigeria.
W91-05002 2H

FAHY, E.
Spring Growing Period as a Regulator of the Size of the Smolt Run in Trout (Salmo trutta).
W91-05000 2H

FAIRCHILD, G. W.
Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

FAIRWEATHER, V.
U.S. Tackles Leaking Tanks.
W91-05070 5G

FALLER, J. A.
Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

FANG, C. S.
Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

FANNIN, R. J.
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

FARAG, S. A.
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

FARHOUDI, J.
Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

FARRINGTON, J. W.
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

FASCHING, J. L.
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

FEDORAK, P. M.
Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

FEDOROVA, T. A.
Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

FEHAN, B.
Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

FEIGENBAUM, S.
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

FELDMAN, A. D.
Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

FELGER, R. S.
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

FEMINELLA, J. W.
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

FERGUSON, J. M.
Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

FERNANDEZ-CASALDERREY, A.
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

FERNANDEZ, D. F. P.
Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

FERNANDEZ, J. M.
Caesium Distribution in Northwest Mediterranean Seawater, Suspended Particles and Sediments.
W91-05453 5B

FERNANDEZ, J. V.
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

FERNANDEZ, P. C.
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

FERNANDEZ, V.
History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

FERNANDO, H. J. S.
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

FERRANDO, M. D.
Changes of Oxygen Consumption on Procambarus clarkii Exposed to Methidathion: Effect on Isolated Gills.
W91-05467 5C

FERREIRA, A. M.
Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

FERRIER, R. C.
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

FERRIS, J. E.
Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

FERRY, L.
Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

FEUILLET-GIRARD, M.
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

FEVRALEVA, L. T.
Removal of Natural Radionuclides from Soil in Lysimetric Water.
W91-05225 5B

FIGUEROA, A.
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

FILIPEK, L. H.
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

FINDLAY, M.
Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

FINLAYSON, C. M.
Sediment Seedbanks in Grasslands on the Magela Creek Floodplain, Northern Australia.
W91-04985 2H

FISHMAN, Y. A.
System for Determining the Design Characteristics of Rock Masses.
W91-05304 8E

FITZGERALD, J.
Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

FITZGERALD, P. A.
Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

FITZSIMONS, R.
Anaerobic Dechlorination/Degradation of Chlorinated Organic Compounds of Different Molecular Massed in Bleach Plant Effluents.
W91-04955 5D

FLAHERTY, T. J.
Anchoring a Dam.
W91-05069 8A

FLEET, B.
Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

FLYTZANI-STEPHANOPOULOS, M.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

FOECKE, T.
Source Reduction Opportunities in the Plating Industry.
W91-05674 5D

FOGEL, S.
Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

FOLKERTS, A.
Monitoring the Toxicity of Organic Compounds Dissolved in Rhine Water.
W91-04957 5B

FORD, W. M.
Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

FORJA, J. M.
Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

FORNERO, L.
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

FORSBERG, C.
Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

FORSTER, B. A.
Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

FOSS, G. M.
Use of Chloramines - Past, Present and Future.
W91-05212 5F

FOSS, L.
Closed Loop Plating System for Waste Minimization.
W91-05676 5G

FOSTER, B. D.
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

FOSTER, N. W.
Volume Recorder for Lysimeter Waters.
W91-05189 2G

FOSTER, S. S. D.
Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

FOUFOULA-GEORGIOU, E.
Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

FOUST, C.
Performance and Application of Ultraviolet Light Systems.
W91-05708 5F

FOWLER, S. W.
Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

FOX, G.
Economics of Erosion and Sediment Control in Southwestern Ontario.
W91-05849 4D

FOX, P.
Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

FOY, G.
Oil and Gas Activity and Louisiana Wetland Loss.
W91-04966 4C

FRAGA, F.
Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

FRANKENBERGER, W. T.
Production and Stability of Ethylene in Soil.
W91-05337 2G

FREEMAN, H. M.
USEPA Pollution Prevention Research Program.
W91-05669 5G

FRICKERS, T. E.
Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

FRIESEN, K. J.
Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

FRIND, E. O.
Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

FRITSCH, A. F.
Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

FRITTON, D. D.
Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

FRITZ, P.
Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

FRITZ, S. J.
Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

FRODGE, J. D.
Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

FROLOV, A. N.
Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

FRUHEN, M.
Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

FRY, J. C.
Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

FRYE, W. W.
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

FUENTES, H. R.
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

FUGGLE, R.
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

FUJIYOSHI, K.
Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

FUKUDA, S.
Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

FUKUNAGA, I.
Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

FURUMAI, H.
Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

GABRIEL, K. R.
Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

GADBOIS, D. F.
Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

GADEL, F.
Contribution of the Rhone River to Organic Carbon Inputs to the Northwestern Mediterranean Sea.
W91-05458 2J

Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

GALENO, G.
Screening of White-Rot Fungi for Efficient Decolourization of Bleach Pulp Effluents.
W91-05101 5D

GALIN, T.
Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

GALLAGHER, K.
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

GALLI, E.
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

GANGAWARE, T. R.
Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

GANSERT, D.
Substituting Thermal Spraying for Electroplating.
W91-05675 5G

GANTZER, C. J.
Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

GARABEDIAN, S. P.
Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

GARCIA MARTINEZ, P.
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

GARDE, R. J.
Annual Runoff Estimation for Catchments in India.
W91-05786 2E

GARDNER, M. K.
Soil Controls on Recharge to Aquifers.
W91-05469 2F

GARZA, D. Q.
Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

GASKIN, P. N.
Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

GATES, T. K.
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

GATTO, L. W.
Monitoring River Ice with Landsat Images.
W91-05031 2C

GAUR, J. P.
Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

GAVILAN, L.
Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

GEE, G. W.
Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

GEIRNAERT, W.
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

GELDENHUYS, J. C.
Automated Flow and pH Control in a Pilot Plant Fluidized Bed Reactor.
W91-05283 5D

GEORGAKAKOS, K. P.
Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

GEORGES, J.
Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

GERASIMENKO, V. P.
Theoretical Principles of Water Erosion Control on Cropland.
W91-05827 4D

GERBA, C. P.
Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

GERMAIT, S. J.
Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

GERMANN, P. F.
Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

GERSBERG, R. M.
Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

GERSTL, Z.
Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

GHAHRAMAN, V. G.
Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

GHOSH, S.
Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

GIANI, D.
Characteristics of a Marshland Soil Built Up from Marine and Peat Material.
W91-05568 2H

GIANI, L.
Characteristics of a Marshland Soil Built Up from Marine and Peat Material.
W91-05568 2H

GIBBS, P. E.
Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

GICHUKI, F. N.
Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

GIESY, J. P.
Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

GIGA, J. V.
Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

GILBERT, P. A.
Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

GILBERT, R.
Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

GILL, R.
Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

GILMOUR, C. C.
Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

GINES SANCHEZ, C.
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

GINGLE, A. R.
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

GIORGETTI, M. F.
Effect of Strip Bed Roughness on the Reaeration Rate Coefficient.
W91-05521 5G

GLADWELL, J. S.
International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

GLANTZ, M. H.
Does History Have a Future. Forecasting Climate Change Effects on Fisheries by Analogy.
W91-05168 2B

GLASS, G. E.
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

GLEBOVA, F. E.
Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

GLEDHILL, W. E.
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

GLEICK, P. H.
Climate Change, Hydrology, and Water Resources.
W91-05799 2A

GODBOLE, S. H.
Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

GODET, C. H.
Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

GODIN, G.
Tidal Hydraulics of Saint John River.
W91-05783 2L

GOFF, F.
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

GOLDMAN, D. M.
Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

GOLUEKE, C. G.
Biological Treatment for Hazardous Wastes.
W91-05843 5D

GOMEZ-PARRA, A.
Circadian Rhythms and Vertical Profiles in a Shallow Marine Ecosystem (Ritmos Circadianos y Perfiles Verticales en un Ecosistema Litoral Somero).
W91-05172 2L

GONENC, I. E.
Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

GONZALEZ, M.
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

GONZALEZ-MARTINEZ, S.
Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

GORDIYENKO, V. P.
Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

GOTLIB, Y. L.
Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

GOTO, K.
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

GOTO, T.
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

GOULD, C. L.
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

GOULEAU, D.
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

GOURDON, R.
Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

GOWLAND, R. T.
History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

GOYAL, M. R.
Estimation of Total Water Consumption of Selected Vegetable Crops in the Semiarid and Humid Regions of Puerto Rico.
W91-05632 3F

GRAHAM, M. E. D.
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

GRAHAM, R. C.
Assessment of Performance of Wet Atmospheric Deposition Samplers. Part 2. Validation of Siting Criteria.
W91-04972 7B

GRANGER, R. J.
Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

GRAPPELLI, A.
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

GRASMICK, A.
Magnesium Induced Algal Flocculation in a Fluidized Bed.
W91-05779 5D

GRATHWOHL, P.
Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

GRAY, D. M.
Examination of Morton's CRAE Model for Estimating Daily Evaporation from Field-Sized Areas.
W91-05445 2D

GREAVES, J.
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

GREENTHAL, J. L.
Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

GRENIER, G.
Substituting Thermal Spraying for Electroplating.
W91-05675 5G

GRIEVE, I. C.
Variations in Chemical Composition of the Soil Solution over a Four-Year Period at an Upland Site in Southwest Scotland.
W91-05564 2G

GRIFFIN, S. D.
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

GRIFFIOEN, J.
Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

GRIFFITH, B. E.
Legal Concepts in Water Management: Shaping the Law to Serve the Public Interest.
W91-05138 6E

GRIGORYAN, K. V.
Effect of Irrigation Waters Polluted with Industrial Wastes on Heavy-Metal Concentration in Soil and in Certain Crops.
W91-05235 5B

GRILLOT, J. C.
Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

GROEGER, G.
Revival of Incineration in the UK.
W91-05507 5D

GROHMANN, A.
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

GROHMANN, G. S.
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

GROSS, C.M.
Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

GROWNS, I. O.
Efficiency Estimates of a Stream Benthos Suction Sampler.
W91-05006 7B

GRUBBS, R. B.
Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

GSCHWEND, P. M.
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

GUCINSKI, H.
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

GUERTIN, P.
Septage-Only Treatment Plant Opens After 19 Years of Hurdles.
W91-05025 5D

GUINASSO, N. L.
Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

GUJER, W.
Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

GULLEDGE, W. P.
Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

GULLIVER, J. S.
Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

GUNDERSEN, A. T.
Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

GUNNISON, D.
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

GUO, S. L.
Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

GUPTA, A. D.
Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

HABERL, R.
Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

HADLEY, P.
DHS Waste Reduction Program.
W91-05670 5G

HADLEY, P. W.
'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

HAFEZ, A. A.
Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

HAGGAR, C.
Making Groundwater Safe to Drink.
W91-05034 5G

HAJJAR, L. M.
Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

HALDEMAN, W. R.
Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

HALE, R. C.
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

HALL, D. A.
Microbiology and Water Chemistry of Two Natural Springs Impacted by Grazing in South Central Nevada.
W91-05204 5C

HALTEMAN, W. A.
Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

HAMANN, C. L.
Potable Water Reuse.
W91-05809 5D

HAMDAN, L.
Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

HAMPTON, D.
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

HANAKI, K.
Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

HANAZATO, T.
Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

HANDA, B. K.
Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

HANDLER, P.
USA Corn Yields, The El Nino and Agricultural Drought: 1867-1988.
W91-05375 2B

HANDY, R. D.
Interactions between the Surface of Rainbow Trout, Oncorhynchus mykiss, and Waterborne Metal Toxicants.
W91-05040 5B

HANEY, J.
Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
W91-05243 5G

HANLEY, J. T.
Updating the Smith-Feddes Model.
W91-05277 2B

HANNIGAN, M. F.
Biotechnology Approach to Bioremediation.
W91-05144 5G

HANNING, G. E.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

HANSEN, C. L.
Biological Treatment of Mercury Waste.
W91-05692 5D

HANSEN, D. J.
Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

HANSEN, M. E. F.
Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

HANSON, A. T.
Effects of Temperature on Turbulent Flocculation: Fluid Dynamics and Chemistry.
W91-05022 5F

HANSON, H.
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

HARADA, S.
Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

HARBOE, R.
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

HARDIG, J.
Micronucleus Test in Fish for Monitoring the Genotoxic Effects of Industrial Waste Products in the Baltic Sea, Sweden.
W91-05944 5A

HARDISON, L. C.
Groundwater Remediation Plan.
W91-05033 5G

HARKIN, J. M.
Influence of Detergent Formulation on Nutrient Movement Through Sand Columns Simulating Mound and Conventional Septic System Drainfields.
W91-05415 5B

HARPER, S. S.
Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

HARRIS, C. M.
Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

HARRIS, H. J.
Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

HARRIS, R. C.
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

HARRISON, J. E.
Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

HART, W. E.
Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

HARTIKAINEN, H.
Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

HARTLEY, D.
DHS Waste Reduction Program.
W91-05670 5G

HARTMAN, H.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

HARTMAN, J. M.
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

HARVEY, R. W.
Use of Colloid Filtration Theory in Modeling Movement of Bacteria through a Contaminated Sandy Aquifer.
W91-05958 5B

HASEBE, T.
Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

HASEGAWA, T.
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

HASHIMOTO, K.
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

HASHIMOTO, S.
Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

HASTENRATH, S.
Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

HATCH, G. L.
New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

HAUCK, L. M.
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

HAWKINS, L. E.
Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

HAYA, K.
Seasonal Lethality of Pentachlorophenol to Juvenile Atlantic Salmon.
W91-05011 5C

HAYANO, I.
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

HAYES, M. J.
Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

HAZLETT, P. W.
Volume Recorder for Lysimeter Waters.
W91-05189 2G

HEDENQUIST, J. W.
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

HEIJNEN, J. J.
Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

HEIKKINEN, K.
Nature of Dissolved Organic Matter in the Drainage Basin of a Boreal Humic River in Northern Finland.
W91-05394 2H

HEIM, R.
Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

HENATSCH, J. J.
Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

HENDERSHOT, W. H.
Copper and Zinc Sorption on Some B Horizons of Quebec Soils.
W91-05338 5B

HENDRICKX, J. M.
Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

HENDRICKX, J. M. H.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

HENDRIX, F.
Biotechnology Approach to Bioremediation.
W91-05144 5G

HENDRY, M. J.
Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

HENRY, E. C.
Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

HERMAN, J. S.
Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

Significance of Chemical Boundaries to Ground-Water Management of Coastal Aquifers.
W91-05615 4B

HERMANN, S.
Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

HERMENS, J. L. M.
Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

Influence of Cytochrome P450 Mixed-Function Oxidase Induction on the Acute Toxicity to Rainbow Trout (Salmo gairdneri) of Primary Aromatic Amines.
W91-05104 5C

HERNANDEZ DELGADO, E. A.
Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

HERTZ, D. W.
Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

HESELTINE, C.
Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

HETTLER, W. F.
Temporal Distribution of Ichthyoplankton near Beaufort Inlet, North Carolina.
W91-05593 2L

HEUSSNER, S.
210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

HEYRAUD, M.
210-Po, 210-Pb in Sediment Trap Particles on a Mediterranean Continental Margin.
W91-05456 2J

HICKEY, R. F.
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

HIGER, A. L.
Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

HIKOSAKA, Y.
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

HILL, E. P.
Organochlorine Contaminants in Eggs and Tissue of Wood Ducks from Mississippi.
W91-05009 5B

HILL, R. L.
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

HINCHEE, R. E.
Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

HINDY, K. T.
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

HIRAI, E.
Airborne Trace Metals in Snow on the Japan Sea Side of Japan.
W91-05355 5B

HIRAOKA, M.
Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

HJORTH, P. G.
Stability of Free Surface Sediment Flow.
W91-05170 2J

HO, G. E.
Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

HO, J. S.
Distinguishing Diphenylamine and N-Nitrosodiphenylamine in Hazardous Waste Samples by Using High-Performance Liquid Chromatography/Thermospray/Mass Spectrometry.
W91-04956 5A

HODGES, J. D.
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

HOFFMAN, E. J.
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

HOFFMAN, G.
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

HOFFMAN, J. R.
Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

HOFFMAN, Z.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

HOGAN, P. J.
Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

HOLBROOK, G.
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

HOLDER, M.
Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

HOLLADAY, S. K.
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

HOLLAND, R. M.
Arsenic Waste Reduction in the Electronics Industry.
W91-05690 5D

HOLS, J.
Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

HONEYCUTT, C. W.
Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

HOOGENDOORN, E.
Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

HORNBERGER, G. M.
Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

HORNBURG, C. D.
Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

HORNSBY, M.
Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

HORTON, R.
Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

HOSOMI, M.
Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

HOUSTON, S. L.
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

HSIEH, G. C.
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

HSU, S. K.
Automatic Parameters Calibration Technique for Rainfall-Runoff Modelling.
W91-05622 2B

HUANG, A. B.
Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

HUANG, C.-H.
Portable Laser Scanner for Measuring Soil Surface Roughness.
W91-05186 2J

HUANG, H.
One-Dimensional Tracer Model.
W91-05815 2F

HUANG, W.-C.
Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

HUANG, W. W.
Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

HUBER, J. K.
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

HUBERT, P.
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Sahelienne a l'Echelle Decametrique).
W91-05850 2B

HUCK, P. M.
Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

HUETE, A. R.
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

HUGHES, R.
Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

HULBERT, G.
Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

HULSE, G.
Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

HULTGREN, J.
Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

HUNT, J. W.
Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

HUSAIN, T.
Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

HUTCHINS, S. R.
Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

HUTCHINSON, S.
Physiological and Morphogenetic Effects of Monophenyltin Trichloride on Ocenebra erinacea (L).
W91-05048 5C

HUYARD, A.
Membrane Bioreactor on Domestic Wastewater Treatment Sludge Production and Modelling Approach.
W91-05768 5D

HWANG, G.-P.
Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

HWANG, P.
Influence of Glucose Supplement on the Degradation of Catechol.
W91-05726 5D

ICHIKAWA, T.
Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

ICHIMURA, M.
Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

IKAWA, H.
Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

IKONNIKOV, L. B.
Prediction of the Destruction of the Banks of the Cheboksary Reservoir as a Result of a Rise of the Level.
W91-05301 2J

ILMAVIRTA, V.
Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

IMABAYASHI, S.
Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

IMAI, T.
Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

INGRAHAM, N. L.
Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

INMULA, P.
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

INOUE, Z.
Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

IPPOLITOVA, L. F.
Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

IRIZARRY, M. M.
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

ISHIDA, T.
Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

ISHIGURO, M.
Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

ISHII, H.
Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

ISHII, Y.
Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

ISHIWATARI, M.
Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

ISLAM, T.
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

ITO, M.
Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

ITO, T.
Sludge Incineration Process of Kyoto City--The Employment and Heat Balance of the Step Grate Stoker Furnace.
W91-05503 5D

ITOH, M.
Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

ITTEKKOT, V.
Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

IVONIN, V. M.
Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

IWABU, H.
Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

IWAKUMA, T.
Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

IWATA, H.
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

IZMAYLOVA, N. B.
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

JABRO, J. D.
Simulation of Water Flow from a Percolation Test Hole in Layered Soil.
W91-05175 2G

JACKSON, P. J.
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

JACOBS, H. J.
Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

JACOBSEN, T. R.
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

JAFFE, P. R.
Volatilization of Organic Compounds in Unsaturated Porous Media During Infiltration.
W91-05418 5B

JAIN, S. C.
Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

JAMES, A.
Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

JAMES, W. F.
Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

JAMET, P.
Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

JANSE, J. H.
Modelling Phosphorus Fluxes in the Hypertrophic Loosdrecht Lakes.
W91-04963 5C

JARDINE, P. M.
Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

JAROG, D. J.
Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

JENKINS, A.
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

JENSEN, B. K.
Biodegradation Kinetics of Phenols in an Aerobic Biofilm at Low Concentrations.
W91-05745 5D

JENSEN, F. B.
Sublethal Physiological Changes in Freshwater Crayfish, Astacus astacus, Exposed to Nitrite: Haemolymph and Muscle Tissue Electrolyte Status, and Haemolymph Acid-Base Balance and Gas Transport.
W91-04994 5C

JENSEN, M.
Rain-Runoff Parameters for Six Small Gauged Urban Catchments.
W91-05381 2B

JENSEN, T.
Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

JIANG, Q.
Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

JIN, J. S.
Foundation Construction within Wastewater-Treatment Plant.
W91-05317 8D

JOHNSON, B. A.
Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

JOHNSON, C. A.
Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
W91-05332 5A

JOHNSON, D. L.
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

JOHNSON, L. H.
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

JOHNSON, R. C.
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

JOHNSON, S. H.
Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

JOHNSTONE, H.
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

JONES, B.
Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

JONES, E. O.
Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

JONES, J. R.
Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

JONES, K. C.
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

JONES, L. F.
Can the United States Afford Biomonitoring.
W91-05143 5G

JONES, R. L.
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

JONES, T. W.
Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

JOOST, R. E.
Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

JORGENSEN, B. B.
Diffusive Boundary Layer of Sediments: Oxygen Microgradients over a Microbial Mat.
W91-05584 2H

Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

JOSHI, J. B.
Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

JOY, C. M.
Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

JUANICO, M.
Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

JUAW, C. K.
Nitrification and Denitrification of High-Strength Ammonium and Nitrite Wastewater with Biofilm Reactors.
W91-05749 5D

JURY, W. A.
Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

JUTTNER, F.
Occurrence and Distribution of Methane Thiol and Other Volatile Sulphur Compounds in a Stratified Lake with Anoxic Hypolimnion.
W91-04999 2K

KAHN, A. R.
Effect of Irrigation Schedule on Soil Temperature.
W91-05476 3F

Response of Peanut to Moisture Stress and Irrigation.
W91-05475 3F

KAKHNOVICH, Z. N.
Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

KALA, D. K.
Computer Automation in Anaerobic Digestion of Brewery Waste.
W91-05296 5D

KALKAT, J. S.
Determination of Exchangeable Sodium Status of Salt-Affected Soils and its Relationship with Growth of Plants.
W91-05477 2K

KALKSTEIN, L. S.
Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

KAMAGATA, Y.
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

KAMINSKI, R. M.
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

KAMON, M.
Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

KAMPBELL, D. H.
Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

KAMPHUIS, J. W.
Erosion Tests on Four Intact Ontario Clays.
W91-05366 2J

KANARSKII, V. F.
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

KANEKO, M.
Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

KANEKO, S.
Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

KANG, M.
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

KANWAR, R. S.
Use of Adsorbed and Non-Adsorbed Tracers to Study the Transport of Agricultural Chemicals to Shallow Groundwater.
W91-05660 5B

KAPILEVICH, Z. A.
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

KAPLAN, S.
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

KAPLINSKIY, M. K.
Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

KARAPANAGIOTIS, N. K.
Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

KARHADKAR, P. P.
Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

KARLSON, A. A.
State and Problems of On-site Observations at Hydro Developments by Geodetic Measurements.
W91-05310 8C

KARPACHEVSKIY, L. O.
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

KARR, B. L.
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

KASAKURA, T.
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

KATAOKA, T.
Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

KATKO, T.
Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

KATSURA, T.
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

KATZ, B. G.
Aqueous Geochemistry of the Sand-and-Gravel Aquifer, Northwest Florida.
W91-05820 2K

KAWABE, H.
Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

KAWAGUCHI, S.
Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

KAWARURA, K.
Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

KAWASE, M.
Development of High-Performance Thermophilic Two-Phase Digestion Process.
W91-05721 5D

KAWASHIMA, T.
Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

KAYSER, N.
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

KEBLER, D. G.
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

KEEFER, D. A.
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

KEETER, F.
Comprehensive Study of East Fork of the Tombigbee: Resource Issues by the Corps of Engineers and Soil Conservation Service.
W91-05139 2E

KEIR, D.
Sewage Clarification with Magnetite Particles.
W91-05780 5D

KELLY, W. E.
Reliability Model for Soil Liner: Postconstruction.
W91-05126 8G

KELSO, D. D.
Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

KENDZIOREK, M.
Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

KENNEDY, K.
Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

KENNEDY, V. S.
Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

KENNICUTT, M. C.
Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

KEREN, R.
Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

KEREN, Y.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

KERR, E. A.
Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

KERR, J. M.
Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

KERRI, K. D.
Measurement of Operator Training Benefits.
W91-05508 5G

KESKITALO, J.
Occurrence of Vegetated Buffer Zones Along Brooks in the Catchment Area of Lake Tuusulanjarvi, South Finland.
W91-05064 5G

KESSEBOOM, B. H.
Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

KETTERER, M. E.
Determination of Rhenium in Groundwater by Inductively Coupled Plasma Mass Spectrometry with On-Line Cation Exchange Membrane Sample Cleanup.
W91-05091 5A

KETTUNEN, J.
Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

KHALIL, M. T.
Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

KHANNA, P.
Pilot-Scale Distillery Spentwash Biomethanation.
W91-05319 5D

KHATTAK, R. A.
Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

KHAYDAPOVA, D. D.
Water Regime of Shelterbelts in a Dry Steppe Zone.
W91-05218 2G

KHOKHLOVA, N. A.
Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

KHONDAKER, A. N.
Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

KHOROST'YANOV, V. I.
Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

KHOSITASHVILI, G. R.
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

KHUDENKO, B. M.
Feasibility Evaluation of a Novel Method for Destruction of Organics.
W91-05515 5D

KICHUK, I. D.
Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

KIEFER, C. A.
Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

KIKUCHI, K.
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

KILHAM, P.
Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

KIM, I. S.
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

KIM, N. B.
Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

KIMATA, T.
Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

KIMURA, S.
Japan's Aqua Renaissance 90 Project.
W91-05766 5D

KING, K. M.
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

KING, L. D.
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

Residual Effect of Sewage Sludge on Heavy Metal Content of Tobacco and Peanut.
W91-05404 5B

KING, P.
Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

KINSMAN, J. D.
Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

KITTREDGE, D.
N. H. Water Rights: An Endangered Species.
W91-05214 6E

KIYA, F.
Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

KLADIVKO, E. J.
Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

KLAPES, N. A.
Acute Toxicity of the Natural Algicide, Cyanobacterin, to Daphnia magna.
W91-05105 5G

KLAPWIJK, S. P.
Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

KLEINENDORST, T. W.
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

KLEIVEN, S.
Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

KLIGER, L.
Fractionation of the Organic Matter in Soils and Sediments and Their Contribution to the Sorption of Pesticides.
W91-05466 5B

KLOILA, W. J.
Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

KLUITENBERG, G. J.
Effect of Solute Application Method on Preferential Transport of Solutes in Soil.
W91-05890 2G

KNAPP, J.
Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

KNIGHT, S. S.
Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

KNUTSON, P. L.
Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

KNUTZEN, J.
Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

KOGA, M.
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

KOHUT, R. J.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

KOIZUMI, A.
Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

KOLBE, F. F.
Gas Metering at Sewage Purification Works.
W91-05291 5D

KOLEGA, M.
Disinfection and Clarification of Treated Sewage by Advanced Microfiltration.
W91-05770 5D

KOLOSKOVA, A. V.
Ameliorating Effect of Shelter-Belt Forests on Chernozems.
W91-05222 4D

KOMATSU, T.
Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

KONAE, M.
Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

KONDRAT'EV, V. M.
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

KOO, J. W.
Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

KOPCEWICZ, B.
Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

KOPSINIS, H.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

KOPYTKOV, V. V.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

KORETSKAYA, L. S.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

KOROTKOV, A. A.
Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

KOSMAS, C.
Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

KOSTECKI, P. T.
Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

KOSTER, B. J.
Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

KOSTLE, P. A.
Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

KOSTOGRYZ, P. V.
Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

KOTHYARI, U. C.
Annual Runoff Estimation for Catchments in India.
W91-05786 2E

KOTYUZHAN, A. I.
Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

KOVACS, D. A.
Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

KOVDA, V. A.
Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

KOZHEVNIKOVA, T. E.
Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

KOZIN, I. S.
Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

KRAFT, A.
Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

KRAJEWSKI, W. F.
Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

KRASEVA, I. A.
Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

KRAUS, N. C.
Numerical Simulation of Shoreline Change at Lorain, Ohio.
W91-05782 2J

KRAVCHUK, Y. I.
Soil Formation in Cultivated, Coarse-Textured Sod-Podzolic Soils with Chemical Use.
W91-05220 2G

KREAMER, D. K.
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

KREYDA, N. A.
Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

KREZNOR, W. R.
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

KRISHNAKUMAR, P. K.
Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

KRISHNAN, S. S.
Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

KRONBERG, L.
Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

KSANDER, G. G.
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

KUBA, T.
Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

KUBO, A.
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

KUDEYAROVA, A. Y.
Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

KUDO, A.
Anaerobic (UASB) Treatment of Pulp (CTMP) Wastewater and the Toxicity on Granules.
W91-05520 5D

KUDOYAROV, L. I.
Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

KUENNEN, R. W.
Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

KUGAPRASATHAM, S.
Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

KUKACKA, L. E.
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

KULARATHNA, M. D. U. P.
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

KULKARNI, S. V.
Studies on Interrelationship Between Different Anaerobic Bacteria in Biogas Digester.
W91-05945 5D

KUMAR, A.
Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

KUMMEL, M.
Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

KUNG, K. J. S.
Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

KUO, J.-T.
Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

KURIBAYASHI, S.
Reuse of Treated Wastewater in an Artificial Stream ('Seseragi') in Kawasaki City, Japan.
W91-05551 5D

KUSKOVSKII, V. S.
Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

KUSUDA, T.
Transient Responses of Wastewater Treatment and Biomass Development in a Methanogenic Fluidized Bed.
W91-05740 5D

KUTURIN, I. M.
Plants Protect Water Bodies.
W91-05087 5G

KUYLENSTIERNA, M.
Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

KUZIN, I. P.
Relation between Parameters of Seismic Effects and Intensity.
W91-05308 8E

KUZOVKIN, A. V.
Use of Precast Reinforced-Concrete Beams in the Floors of the Draft Tubes of the Cheboksary Hydroelectric Station.
W91-05081 8F

KVARATSKHELIYA, M. Z.
Effect of Fertilizer Phosphates on Solubility of Ca, Mg, Mn, Al, and Fe Compounds in Gray Forest Soil.
W91-05232 2K

KWIATKOWSKI, P. J.
Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

KYOSAI, S.
Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

LA MARCA, M.
Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

LA ROCHELLE, P.
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

LABARE, M. P.
Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

LABOWSKI, J. L.
Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

LACKEY, R. T.
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

LAI, P. M. C.
Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

LAKE, R. L.
Activated Alumina for POU/POE Removal of Fluoride and Arsenic.
W91-05712 5F

LAKSHMI, V.
Monte Carlo Study of Rainfall Sampling Effect on a Distributed Catchment Model.
W91-05842 2E

LAMM, P.
Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

LANDERS, M. N.
Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

LANG, G. E.
Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

LANGSTON, W. J.
Assessing the Impact of Tin and TBT in Estuaries and Coastal Regions.
W91-05046 5C

LANSEY, K. E.
Parameter Estimation for Water Distribution Networks.
W91-05794 5F

LARKIN, J.
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

LARSEN, M. C.
Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

LATIMER, J. S.
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

LAUBSCHER, D. J.
Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

LAUER, W. C.
Water Quality for Potable Reuse.
W91-05547 5D

LAUGHTER, C.
Lighting Guide for Wastewater Treatment Facilities.
W91-05029 5D

LAURENCE, J. A.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

LAWRENCE, A. R.
Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

LE BIHAN, A.
Determination of 1 ng/l. Levels of Mercury in Water by Electrothermal Atomization Atomic-Absorption Spectrometry after Solvent Extraction.
W91-05800 5A

LE CLOIREC, P.
Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

LEAP, D. I.
Estimating Recharge Rates Through Unsaturated Glacial Till by Tritium Tracing.
W91-05817 2F

LEAVITT, M. E.
Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

LEBEDEV, Y. A.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

LEBO, M. E.
Phosphate Uptake Along a Coastal Plain Estuary.
W91-05580 5B

LECHEVALLIER, M. W.
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

LECKIE, J. O.
Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

LEDOUX, E.
Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

LEE, B. W.
California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

LEE, D.
Economic Feasibility of Drying Municipal Solid-Waste Combustion Residue.
W91-05123 5E

LEE, G. C.
Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

LEE, J. H. W.
Generalized Lagrangian Model for Buoyant Jets in Current.
W91-05323 8B

LEE, K. Y.
Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

LEEDS-HARRISON, P. B.
Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

LEENHEER, J. A.
Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

LEIS, W. M.
Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

LELE, S. S.
Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

LEMAY, J.
Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

LEMLEY, A. T.
Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

LEONARD, R. A.
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

LEONARDS, G. A.
Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

LEOPOLD, B. D.
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

LEPNEVA, O. M.
Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

LERNER, L. A.
Use of Atomic Absorption Spectroscopy with a Graphite Furnace to Determine Arsenic in Natural Waters and Aqueous Soil Extracts.
W91-05829 5A

LEROUEIL, S.
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

LESKINEN, E.
Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

LESSARD, P.
Dynamic Modeling of Wastewater Treatment Processes.
W91-05948 7C

LESTER, J. H.
Utilization of Adipic Acid Byproducts for Energy Recovery and Enhancement of Flue Gas Desulfurization.
W91-05909 5D

LESTER, J. N.
Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

Start-up Regimes for Anaerobic Fluidized Systems Treating Dairy Wastewater.
W91-05844 5D

LETTENMAIER, D. P.
Climatic Sensitivity of California Water Resources.
W91-05793 6B

LETTERMAN, R. D.
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

LEUSCHNER, W. A.
Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

LEWIS, D. T.
Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

LEWIS, M. A.
Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

LEWIS, R. E.
Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

LICHTENBERG, E.
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

LIGNELL, R.
Excretion of Organic Carbon by Phytoplankton: Its Relation to Algal Biomass, Primary Productivity and Bacterial Secondary Productivity in the Baltic Sea.
W91-05590 2H

LIKENS, G. E.
Short-Range Atmospheric Transport: A Significant Source of Phosphorus to an Oligotrophic Lake.
W91-05578 2H

LIN, C. Y.
Anaerobic Digestion of Pesticide-Plant Wastewater.
W91-05846 5D

LIN, G.-F.
Parameter Estimation for Seasonal to Subseasonal Disaggregation.
W91-05431 7C

LINDAU, C.
Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

LINDEN, D. R.
Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

LINDESAY, J. A.
Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

LION, L. W.
Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

LITOVCHENKO, A. A.
Leaching of Saline Soils in the Omsk Oblast by Deep Furrow Irrigation.
W91-05351 2G

LITTLEWOOD, M. H.
Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

LIU, Z.
Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

LIVET, M.
Identification of the Boundaries Between Two Watersheds in a Volcanic Area by the Self-Potential Method (Verification de Limites de Nappes Aquiferes en Terrain Volcanique par la Methode de Polarisation Spontanee).
W91-04939 2F

LIVINGSTONE, D. R.
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

LO, C. P.
Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

LOBARTINI, J. C.
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

LOCKE, M. A.
Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

LOFVENDAHL, R.
Major Element Chemistry, delta-2-H, delta-18-O and 87-Sr/86-Sr in a Snow Profile across Central Scandinavia.
W91-05356 5B

LOGAN, B. E.
Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

LOKA BHARTHI, P. A.
Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

LONG, A.
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

LONG, L. G.
Effects of Record High Mean Monthly Streamflows in Selected Streams North Mississippi in 1989.
W91-05142 2E

LOOS, H.
Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

LORAH, M. A.
Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

LORENZEN, A.
Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

LOTITO, V.
Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

LOUW, A. S.
Chemical Phosphate Removal at Boksburg Water Pollution Control Works: Automation and Control.
W91-05290 5D

LOVEJOY, S.
Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

LOVETT, G. M.
Atmospheric Pollutant Deposition to High Elevation Ecosystems.
W91-05491 5B

LOWE, P.
Revival of Incineration in the UK.
W91-05507 5D

LOWRY, J. D.
Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

LOWRY, S. B.
Modelling Point-of-Entry Radon Removal by GAC.
W91-05713 5F

LOZANOVSKAYA, I. N.
Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

LUBRANO, L.
Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

LUCAMANTE, G.
Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

LUCARELLI, F.
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

LUGANSKAYA, I. A.
Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

LUI, S. M. W.
Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

LUND, J. R.
Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

LUTHY, R. G.
Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

LUTZIC, G. N.
New York City's Plan to End Ocean Disposal of Sludge.
W91-05028 5E

LUXMOORE, R. J.
Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

LYANDRES, S.
Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

LYDERSEN, E.
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

Solubility and Hydrolysis of Aqueous Aluminium Hydroxides in Dilute Fresh Waters at Different Temperatures.
W91-05383 5C

LYKKE-MADSEN, M.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

LYN, D. A.
Resistance in Flat-Bed Sediment-Laden Flows.
W91-05425 2E

MACDONALD, I. R.
Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

MACFARLANE, J. K.
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

MACK, E. J.
Updating the Smith-Feddes Model.
W91-05277 2B

MACKENZIE, N.
Soil Controls on Recharge to Aquifers.
W91-05469 2F

MADANI, A. A.
Economics of Desalination for Three Plant Sizes.
W91-05196 3A

MADZHIDOV, I. U.
Calculated Prediction of Earth Pressures on Tailwater Tunnels of the Rogun Hydroelectric Station.
W91-05076 8E

MAGARA, Y.
Effect of Operational Factors on Solid/Liquid Separation by Ultra-Membrane Filtration in a Biological Denitrification System for Collected Human Excreta Treatment Plants.
W91-05767 5D

MAGEE, B. R.
Effect of Water-Soluble Organic Material on the Transport of Phenanthrene in Soil.
W91-05250 5B

MAGETTE, W. L.
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

MAHFOUF, J.-F.
Numerical Simulation of the Surface Water Budget during HAPEX-MOBILHY.
W91-05357 2D

MAITA, Y.
Amino Acid Sequence of Cadmium-Binding Peptide Induced in a Marine Diatom, Phaeodactylum tricornutum.
W91-05012 5B

MAKI, A. W.
Exxon Valdez Oil Spill: Initial Environmental Impact Assessment.
W91-05947 5C

MALCOLM, R. L.
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

MALEK, E.
Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

MALLEK, J. S.
Wellhead Protection: An Approach to Preservation of Public-Water Supplies.
W91-05617 4B

MALLICK, N.
Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

MALLORY, M. J.
Computer Methods for Evaluating Wellhead Protection Areas.
W91-05153 5G

MALONE, T. C.
Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

MALOT, J. J.
Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

MALTBY, L.
Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

MANES, A.
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

MANI, K. N.
Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

MARAIS, G. R.
D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

MARCIANO, E. A.
Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

MAREE, J. P.
Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

MARIN, C. M.
Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

MARINAS, B. J.
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

MARINO, M. A.
Reservoir Planning for Irrigation District.
W91-05791 6A

Runoff Prediction Uncertainty for Ungauged Agricultural Watersheds.
W91-05130 2E

MARINO, M. G.
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

MARQUEZ, A.
Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

MARRETT, D.J.
Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

MARSHALL, D. B.
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

MARTIN, C. D.
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

MARTIN, G.
Pollutant Adsorption onto Activated Carbon Membranes.
W91-05775 5D

MARTIN, J. P.
Properties and Use of Fly Ashes for Embankments.
W91-05122 8G

Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

MARTIN, M.
Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

MARTIN, R. J.
Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

MARTINEZ, J.
Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

MARULANDA, A.
Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

MASKARINEC, M. P.
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

MASLOV, A. B.
Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

MASON, W. K.
Correlation of Growth of the Root and Shoot Systems of White Clover after a Period of Water Shortage and/or Defoliation.
W91-05498 2I

MASTERS, D.
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

MASUDA, S.
Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

MATHES, K.
Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

MATHEW, K.
Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

MATHEWS, B. W.
Effects of Leaching Surface-Applied Amendments on Subsoil Aluminum and Alfalfa Growth in a Louisiana Ultisol.
W91-05341 5B

MATSON, E. A.
Stable Carbon Isotopes and the C:N Ratio in the Estuaries of the Pamlico and Neuse Rivers, North Carolina.
W91-05581 2L

MATSUBARA, K.
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

MATSUDA, K.
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

MATSUI, T.
Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

MATSUMOTO, A.
Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

MATSUO, T.
Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

MATSUSHIGE, K.
Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

MATTHEWS, W. J.
Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

MATUKHNO, Y. D.
Ability of Soil Under Forest to Purify Fertilizer-Polluted Runoff.
W91-05216 5B

MATVEYEV, Y. M.
Degradation of Terbacil in Soil.
W91-05226 5B

MATZ, S.
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

MAUCHIEN, P.
Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

MAUGHAN, E.
Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
W91-05299 5F

MAURY-BRACHET, R.
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

MAZA, J.
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

MCBEAN, E. A.
Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

MCCAHON, C. P.
Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

MCCORMICK, R.
DHS Waste Reduction Program.
W91-05670 5G

MCCURDY, G. D.
Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

MCDOWELL, C.
Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

MCDOWELL, W. H.
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

MCELROY, A. E.
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

MCEWEN, B.
Potable Water Reuse.
W91-05809 5D

MCFARLAND, D. G.
Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

MCFARLAND, L. K.
Biotechnology Approach to Bioremediation.
W91-05144 5G

MCGINNIS, G. D.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

Biotechnology Approach to Bioremediation.
W91-05144 5G

MCGRATH, D. R.
Effectiveness of Evapotranspiration Systems in Disposing of Wastewater in Remote Aboriginal Communities in Northwest Australia.
W91-05510 5E

MCGRATH, S. P.
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

MCGRIFF, E. C.
Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

MCINTOSH, M.S.
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

MCINTYRE, S. C.
Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

MCKENNA, D. P.
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

MCKENZIE, D. J.
Very Low Frequency Electromagnetic Mapping of a Freshwater Lens at Key West, Florida.
W91-05642 2F

MCKEREGHAN, P. F.
Ground-Water Discharge to Lakes: Focusing in Embayments.
W91-05823 2F

MCKINLEY, P. W.
Baseline Water-Quality Evaluation of Three Basins in the Upper Rio Grande de Arecibo Basin, Puerto Rico.
W91-05655 5B

MCLEARN, M. E.
EPRI-Sponsored Research on Underground Storage Tanks.
W91-05241 5G

MEANS, E. G.
Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

MEARDON, J.
Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

MEDINA, M. A.
Empirical Bayes Regionalization Methods for Spatial Stochastic Processes.
W91-05832 2F

MEHANNI, A. H.
Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

MEHNERT, E.
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

MEIER, E.
Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
W91-05121 8G

MEISNER, J. D.
Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

MELKONIAN, J. J.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

MELTZER, M.
Metal-Bearing Waste Streams: Minimizing, Recycling and Treatment.
W91-05668 5D

MENEGHINI, R.
Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

MERCIER, G.
Bacterial Leaching of Heavy Metals from Sewage Sludge-Bioreactors Comparison.
W91-04943 5D

MERKLEY, G. P.
Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

MERMOUD, A.
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

MERRY, C. H.
Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

MERZ, W. J.
Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

METELSKI, J. J.
Providing Environmental Impairment Liability Insurance Coverage.
W91-05238 5G

METSALA, T. R.
Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

METZGER, B. H.
Toward Economically Efficient Management of Underground Storage Tanks: A Risk-Based Approach.
W91-05264 5G

MEYER, F. G.
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

MEYER, J. L.
Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

MEYER, W. S.
Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

MGALOBELOV, Y. B.
Concept of Safety Evaluation of the Arch Dam of the Inguri Hydroelectric Station.
W91-05082 8A

MICHAEL, L. C.
Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

MICHEL, X.
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

MIHELCIC, J. R.
Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

MIKHAYLUK, V. I.
Degradation of Chernozems on the Danube-Dniester Irrigation System.
W91-05227 3C

MIKKELSEN, D. S.
Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

MILLER, D. R.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

MILLER, J.
Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

MILLER, J. D.
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

MILLER, J. R.
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

MILLOT, C.
Gulf of Lions' Hydrodynamics.
W91-05452 2L

MILLS, A. L.
Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

MILLSPAUGH, M. P.
Implications of Dealing with Real Estate-Based Cleanup Statutes.
W91-05239 6E

MILUTINOVIC, J. D.
Observational and Model Studies of Physical Processes Affecting Benthic Larval Recruitment in Delaware Bay.
W91-05169 8I

MIN'KO, O. I.
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

MIN, Z.
Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

MINAMI, T.
Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

MININNI, G.
Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

MIRONENKO, Y. V.
Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

MISARI, S. M.
Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

MISHINA, F.
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

MISHRA, H. S.
Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

MISSELBROOK, T. H.
Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

MIYAJI, Y.
Penetration of Biocides into Biofilm.
W91-05747 5D

MOERSIDIK, S.
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

MOFFETT, J. M.
Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

MOHAMED ALI, H. S.
Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

MOHR, C. D.
Bioaccumulation of Mutagens and Promutagens in Fish Taken from Four Sites in Northeast Tennessee.
W91-05462 5A

MOLANDER, S.
Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

MOLDEN, D. J.
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

MOLDRUP, P.
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

MOLINARI, R.
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

MOLL, H. G.
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

MOLLERSTEN, I.
Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

MOLNAA, B. A.
Bioremediation of Petroleum Contaminated Soils Using a Microbial Consortia as Inoculum.
W91-05254 5G

MOLOKOV, L. A.
Landslide at the Abutment of the Dam of the Mingechaur Hydroelectric Station.
W91-05307 8D

MONACO, A.
Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

MONKIEDJE, A.
New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

MONTES, P.
Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

MOO-YOUNG, M.
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

MOODY, P. W.
Simple Bioassay for the Diagnosis of Aluminium Toxicity in Soils.
W91-05340 5A

MOODY, R. L.
Stability of Volatile Organic Compounds in Environmental Water Samples during Transport and Storage.
W91-04947 5A

MOORE, A.
Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

MOORMAN, T. B.
Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

MORASSE, C.
Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

MORGAN, S. F.
Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

MORI, T.
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

MORINIGO, M. A.
Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

MORRA, M. J.
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

MORRIS, G. L.
Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

MORRIS, J. G.
Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

MORRIS, L.
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

MORRISON, R. J.
Marine Pollution from Landuse in the Pacific Islands Region.
W91-05343 5B

MORTENSON, D.
Geographic Information System Documentation of Watershed Data for Direct/Delayed Response Project: Southern Blue Ridge Province Database.
W91-05278 7C

MOTOYAMA, H.
Simulation of Seasonal Snowcover Based on Air Temperature and Precipitation.
W91-05857 2C

MOUSTAKA-GOUNI, M.
Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

MOUSTAKAS, N.
Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

MRAVIK, S. C.
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

MUCHOW, R. C.
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

MUDRY, J.
Curves of Chemical Flux Versus Discharge and Working of Karst Aquifers (Les Courbes Flux Chimique-Debit et le Fonctionnement des Aquiferes Karstiques).
W91-05443 2F

MUIA, M. J.
Question of Nitrates.
W91-05904 5B

MUIR, D. C. G.
Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

MUKHOPADHYAY, A.
Numerical Simulation of Subsurface-Water Rise in Kuwait City.
W91-05825 2F

MULDER, A.
Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

MULLA, D. J.
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

MUNHALL, A. V.
Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

MUNIZ, A.
Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

MUNIZ, I. P.
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

MUNN, N. L.
Habitat-Specific Solute Retention in Two Small Streams: An Intersite Comparison.
W91-05201 2K

MUNOZ, R.
Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

MURAKAMI, T.
Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

MURRAY, H. E.
Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

MUSSELMAN, R. C.
Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

MYBURGH, H.
Continuous Water Quality Monitoring.
W91-05287 5G

MYERS, K. J.
Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

MYERS, K. L.
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

MYERS, T. E.
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

MYLROIE, J.
Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

NAGAMOTO, C.
Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

NAGAOKA, H.
Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

NAGAOSA, Y.
Separation and Simultaneous Determination of Aluminum, Iron, and Manganese in Natural Water Samples by Using High-Performance Liquid Chromatography with Spectrophotometric and Electrochemical Detection.
W91-05892 7B

NAGAYA, Y.
239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

NAIDOO, G.
Effects of Nitrate, Ammonium and Salinity on Growth of the Mangrove Bruguiera gymnorrhiza (L.) Lam.
W91-04987 2H

NAKAMURA, K.
239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

NAKANISHI, J.
Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

NAKANISHI, M.
Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

NAKHLA, G. F.
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

NAMBU, T.
Wastewater Treatment by a Submerged Contact Media Process Using Net Plates.
W91-05513 5D

NANEY, J. W.
Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

NARASIAH, K. S.
Nutrient Removal from Aerated Lagoons Using Alum and Ferric Chloride-A Case Study.
W91-05765 5D

NARASIMHAN, T. N.
Fluid Flow in Partially Saturated, Welded-Non-welded Tuff Units.
W91-05883 2F

NARAYANAN, R.
Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

NARBONNE, J. F.
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

NASH, M. S.
Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

NATIV, R.
Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

NAYLOR, C.
Preliminary Observations on the Ecological Relevance of the Gammarus 'Scope for Growth' Assay: Effect of Zinc on Reproduction.
W91-05041 5A

NEIDERT, S. H.
Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

NELSON, W. G.
Development and Use of Site-Specific Chemical and Biological Criteria for Assessing New Bedford Harbor Pilot Dredging Project.
W91-05907 5G

NENOV, V.
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

NEZU, I.
Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

NG, K. C.
Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

NIEDERLEHNER, B. R.
Effects of Ammonia on Periphytic Communities.
W91-04942 5C

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

NIELSEN, P. H.
Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

NIGAGLIONI, R. G.
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

NIKIFOROVA, Y. M.
Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

NIKOLAIDIS, G.
Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

NISHIKAWA, S.
Penetration of Biocides into Biofilm.
W91-05747 5D

NISHIMURA, K.
Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

NISSAN, E.
Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

NIX, P. G.
Use of Sediment Bags as a Monitor of Fecal Pollution in Streams.
W91-05008 5A

NKEDI-KIZZA, P.
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

NOIKE, T.
Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

Effects of Substrate Composition and Loading Rate on Methanogenic Process in Anaerobic Fluidized Bed Systems.
W91-05738 5D

NONAKA, T.
Microbial Corrosion of Concrete Sewer Pipes, H2S Production from Sediments and Determination of Corrosion Rate.
W91-05734 5D

NONTANANANDH, S.
Combining Industrial Wastes with Lime for Soil Stabilization.
W91-05867 5E

NORTH, G. R.
Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

NORTON, L. D.
Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

NORWOOD, D. L.
Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

NOYES, T. I.
Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

NULLET, D.
Local Differences in Soil Temperature and Soil Moisture Regimes on a Mountain Slope, Hawaii.
W91-05569 2G

NUMAKURA, T.
Penetration of Biocides into Biofilm.
W91-05747 5D

NYFFELER, F.
Hydrographic Structure and Nepheloid Spatial Distribution in the Gulf of Lions Continental Margin.
W91-05454 2J

O'BRIEN, D. P.
Deterministic Signals in USA Precipitation Records: Part I.
W91-05374 2B

O'HARA, S.
Oxyradical Production as a Pollution-Mediated Mechanism of Toxicity in the Common Mussel, Mytilus edulis L., and Other Mollusks.
W91-05044 5C

OBERDORFER, J. A.
Atoll Island Hydrogeology: Flow and Freshwater Occurrence in a Tidally Dominated System.
W91-05446 2F

OBERTS, G. L.
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

OBUKHOV, A. I.
Biochemistry of Heavy Metals in an Urban Environment.
W91-05224 5B

ODENDAAL, P. E.
Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

OEHME, M.
Estimation of Polychlorinated Dibenzofuran and Dibenzo-p-dioxin Contamination of a Coastal Region Using Isomer Profiles in Crabs.
W91-05074 5B

OGURO, H.
Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

OHGAKI, S.
Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

OHKAWA, T.
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

OHKUBO, Y.
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

OHMS, M. T.
Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

OHNO, T.
Levels of Total Cyanide and NaCl in Surface Waters Adjacent to Road Salt Storage Facilities.
W91-05111 5B

OHTA, K.
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

OKABE, T.
Experiments on Sea Water Desalination by Membrane Distillation.
W91-05195 3A

OKAMOTO, A.
Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

OKEY, A. B.
Detection and Characterization of (3H)2,3,7,8-Tetrachlorodibenzo-p-dioxin Binding to Ah Receptor in a Rainbow Trout Hepatoma Cell Line.
W91-05830 5C

OLAYINKA, A. I.
Electromagnetic Profiling for Groundwater in Precambrian Basement Complex Areas of Nigeria.
W91-05384 2F

OLES, J.
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

OLIVER, R. L.
Optical Properties of Waters in the Murray-Darling Basin, South-Eastern Australia.
W91-05004 2E

OLMEZ, I.
Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

OLSON, K. R.
Quantification of Postsettlement Deposition in a Northwestern Illinois Sediment Basin.
W91-05185 2J

Soil, Landscape, and Erosion Relationships in a Northwest Illinois Watershed.
W91-05606 2J

OMOTOSHO, J. B.
Onset of Thunderstorms and Precipitation over Northern Nigeria.
W91-05377 2B

OMURA, T.
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

ONG, S. K.
Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

ONG, S. L.
Study of Reclamation of Sewage for Industrial Waters.
W91-05548 3E

ONIKIENKO, T. S.
Effect of Changes in the Geocryological Conditions in the Basin of Reservoirs on Functioning of Northern Hydroelectric Stations.
W91-05300 8C

ONITSUKA, T.
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

ONUMA, M.
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

ORHON, D.
Application of Biofilm Kinetics to Anaerobic Fixed Bed Reactors.
W91-05739 5D

ORLOV, D. S.
Chemical Reclamation of Saline-Sodic Soils of the Lower Don Floodplain by Some Industrial Wastes.
W91-05576 2G

Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

ORON, G.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

ORTH, R. G.
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

OSADCHUK, V. A.
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

OSAE, E.
Environmental Impact of Gold Mining Industry in Ghana.
W91-05896 4C

OSGOOD, R. A.
Water-Quality Effectiveness of a Detention/Wetland Treatment System and Its Effect on an Urban Lake.
W91-05908 5D

OSTENDORF, D. W.
Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

OSTER, J. D.
Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

OTTERMAN, J.
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

OUYANG, C.
Increased Stability of Anaerobic Digestion by Controlled Recirculation.
W91-05729 5D

OWANO, C.
Groundwater Remediation Plan.
W91-05033 5G

OWENS, L. B.
Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

PABST, G. S.
Water Quality of a Carbonate Island Karst Aquifer, San Salvador Island, Bahamas.
W91-05654 2F

PACHEPSKIY, Y. A.
Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

PACHERO, P. A.
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

PACK, E.
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

PADNYA, A. M.
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

PAGAN-TRINIDAD, I.
Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

PAGE, A. L.
Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

PAGE, N. P.
Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

PAGLIAI, M.
Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

PAIN, B. F.
Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

PAINCEIRA, M. T.
Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

PAINULI, D. K.
Effect of Polyvinyl Alcohol, Dextran and Humic acid on Some Physical Properties of a Clay and Loam Soil: I. Cracking and Aggregate Stability.
W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

PALAVEYEV, T. D.
Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

PALIT, T. T.
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

PALMER, A. N.
Origin and Morphology of Limestone Caves.
W91-05851 2F

PANDAY, S.
Solute Rejection in Freezing Soils.
W91-05840 2K

PANDIT, A. K.
Floods Threatening Kashmir Wetlands.
W91-05385 2E

PANFILOV, V. S.
Hydrogeothermal Theory of Earthquakes--Basis of Prediction, Warning Systems, and Counteractions.
W91-05316 8E

PANSINI, M.
Dynamic Data on Lead Uptake from Water by Chabazite.
W91-05199 5D

PANT, R. C.
Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

PANTANO, G.
Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
W91-05198 5D

PANTELEEV, V. G.
Classification of the Thermal Regime of Hydraulic-Fill Structures in the Winter Period of Operation.
W91-05084 5E

PAPP, C. S. E.
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

PARK, J. K.
Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

PARK, K. S.
Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

PARKER, J. C.
Multiphase Flow and Transport in Porous Media.
W91-05798 5B

PARKER, R. D. R.
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

PARKIN, G. F.
Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

PARLANGE, J. Y.
Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

PARUNGO, F.
Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

PASCOE, D.
Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

PATAMATAMKUL, S.
Economic and Engineering Considerations for Planning Medium Scale Irrigation Systems: A Study from Northeast Thailand.
W91-05633 3F

PATRICK, D. M.
Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

PATRICK, W. H.
Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes.
W91-05587 2L

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

PAUDYAL, G. N.
Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

PAULEY, G. B.
Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

PAVLICK, R.
Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

PAYMENT, P.
Bacterial Colonization of Domestic Reverse-Osmosis Water Filtration Units.
W91-05939 5F

PEARSON, F. H.
Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

PEDERSEN, K. M.
Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Wastewater Treatment Plant.
W91-05331 5D

PEDROLI, B.
Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

PEKKARINEN, M.
Comprehensive Survey of the Hypertrophic Lake Tuusulanjarvi: Nutrient Loading, Water Quality and Prospects of Restoration.
W91-05061 5G

PELLIZZARI, E. D.
Application of the Master Analytical Scheme to the Determination of Volatile Organics in Wastewater Influents and Effluents.
W91-05955 5A

PENA, G.
Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

PENKOV, M. D.
Properties of Surface Waterlogged Clay Soils Containing Exchangeable Mg.
W91-05228 2G

PENNINGTON, J. C.
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

PEREZ, L.
Influence of Tidal Conditions and River Volume on Phytoplankton Distribution and Composition in the Pas Estuary (Northern Spain).
W91-05173 2L

PERO, R. W.
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

PERRY, E. C.
Aspects of the Hydrogeology of the Northwest Region, Yucatan Peninsula, Mexico.
W91-05647 2F

Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

PERSHUTKINA, A. M.
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

PESCOD, M. B.
Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

PETERSEN, S. P.
Analysis of Sulfate in Sewage Sludge using Ion Chromatographic Techniques.
W91-05571 5D

PETERSON, C. G.
Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

PETERSON, W. A.
Operational Quality in Wastewater Management.
W91-05806 5D

PETRUZZELLI, G.
Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

PEYTON, R. L.
Evaluation of Constructed and Natural Soil Macropores Using X-Ray Computed Tomography.
W91-05874 8D

PEZZAROSSA, B.
Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

PHILIP, J. R.
Hillslope Infiltration: Planar Slopes.
W91-05841 2G

PHILIPP, C. T.
Solids Detoxification: Metals Recovery.
W91-05680 5D

PHILLIPS, F. M.
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

PHILLIPS, P. E.
Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

PICOT, B.
Nutrient Removal by High Rate Pond System in a Mediterranean Climate (France).
W91-05762 5D

PIERSON, F. B.
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

PIKE, S.
Seasonal Contrasts in Diurnal Carbon Incorporation by Phytoplankton Size Classes of the Coastal Plume of Chesapeake Bay.
W91-05591 2H

PILLAI, V. K.
Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

PINDER, J. E.
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

PLATONOVA, T. K.
Calculation of Mass-Exchange Processes in Leached Soils.
W91-05353 2G

PNUEL, Y.
Physiological Attributes Associated with Drought Resistance of Wheat Cultivars in a Mediterranean Environment.
W91-05496 2I

POBEDOV, V. S.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

POCKLINGTON, R.
Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

POETER, E. I.
New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

POETER, E. P.
Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

POLEO, A. B. S.
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

POLLOCK, D. W.
Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

POLPRASERT, C.
Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

POLZER, W. L.
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

PONIZOVSKIY, A. A.
Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

PONNAMBALAM, K.
Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

POOLE, T. S.
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

POOVACHIRANON, S.
Fate of Mangrove Litter in a Mangrove Forest on Ko Yao Yai, Southern Thailand.
W91-05574 2L

POPE, D. F.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

POPEL, H. J.
Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

POPLE, A.
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

PORRETTA, A. M.
Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

PORTER, J. H.
Water Sample Contamination by Glass Fiber and Cellulose Filters.
W91-05559 7B

POTE, J. W.
Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

POTHULURI, J. V.
Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

POTTER, J. L.
Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

POTTER, T. L.
Analysis of Petroleum Contaminated Soil and Water: An Overview.
W91-05245 5A

POWELL, G. M.
Household Water Quality Education: The Cooperative Extension System Role.
W91-05700 5F

PREGO, R.
Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

PRESLO, L. M.
Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

PRICE, G. H.
Movement of Salts in Soil Irrigated with Low and High Conductivity Waters.
W91-05561 3C

PRICE, J. S.
Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

PRIESTLEY, A. J.
Sewage Clarification with Magnetite Particles.
W91-05780 5D

PROBST, J.
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

PUIG, J. C.
Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

PUIGBO, A.
Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

PUMARADA-O'NEILL, L.
Study and Recommendations on the San German Vaulted Brick Storm Sewer System.
W91-05634 5D

PUSKAS, K.
Performance of an Integrated Ponding System Operated in Arid Zones.
W91-05763 5D

PUURMANN, E. L.
Saline Maritime Soils of Estonia.
W91-05229 2G

PYNNONEN, K.
Aluminium Accumulation and Distribution in the Freshwater Clams (Unionidae).
W91-05940 5B

QADRI, S.
Floods Threatening Kashmir Wetlands.
W91-05385 2E

QIN, D.
Bacterial (Total Coliform) Die-Off in Maturation Ponds.
W91-05761 5D

QUINN, J. G.
Sources of Petroleum Hydrocarbons in Urban Runoff.
W91-04967 5B

QUISENBERRY, V. L.
Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

RABA, A.
Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

RABA, R. M.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

RADKE, L. F.
Occurrence and Characteristics of Lower Tropospheric Ice Crystals in the Arctic.
W91-05372 2C

RADSTAKE, F.
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

RAI, L. C.
Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

RAITANIEMI, J.
Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

RAIZMAN, A. P.
Geodetic Investigations of Deformations of the Earth's Crust in the Regions of the Nurek and Rogun Hydroelectric Stations.
W91-05311 8E

RAJADHYAKSHA, P. J.
Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

RAKNESS, K. L.
Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

RAMAYYA NAIDU, P.
Environmental Health.
W91-05051 6G

RAMESH, A.
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

RAMIREZ, C. A.
Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

History of a Chlorpyrifos Spill: Cartagena, Colombia.
W91-05901 5B

RAMOS, J.
Piping and Erosion Tests at Conner Run Dam.
W91-05870 8D

RAMOS PEREZ, C. R.
Influence of Sea Salt Aerosols and Long Range Transport on Precipitation Chemistry at El Verde, Puerto Rico.
W91-05492 5B

RANCE, S. J.
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

RANDALL, E. W.
Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

RANTA, H.M.
Effect of Simulated Acid Rain on Quantity of Epiphytic Microfungi on Scots Pine (Pinus sylvestris L.) Needles.
W91-05390 5C

RAO, K. H.
Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

RAO, P. S. C.
Modeling Solute Transport in Structured Soils: A Review.
W91-05884 2G

RAPP, G. R.
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

RASHID, H.U.
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

RASK, M.
Preliminary Observations on the Effects of Liming to the Fish Populations of Small Acidic Lakes in Southern Finland.
W91-05068 5G

Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

RASMUSSEN, T. C.
Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

RASSKAZOV, L. N.
Optimization of the Designs of Earth Dams.
W91-05083 8A

RATAS, U. A.
Saline Maritime Soils of Estonia.
W91-05229 2G

RATHORE, T. R.
Effect of Intermittent Irrigation on Groundwater Table Contribution, Irrigation Requirement and Yield of Rice in Mollisols of the Tarai Region.
W91-05932 3F

RAUCH, P. A.
Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

RAUNET, M.
Water-Table Fluctuations in Weathered Crystalline Rocks in a High Altitude Humid Intertropical Zone (High Plateaux of Madagascar) (Comportement Piezometrique des Nappes d'Alterites en Zone Intertropicale Humide d'Altitude (Hauts Plateaux de Madagascar)).
W91-05442 2F

RAZUMOV, V. K.
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

REASONER, D. J.
Microbiological Studies of Granular Activated Carbon Point-of-Use Systems.
W91-05710 5F

REBICH, R. A.
Upstream Extent of Saline Water in the Pascagoula River.
W91-05148 6G

RECKHOW, D. A.
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

REDDY, K. R.
Competition for Space Between Eichhornia crassipes (Mart.) Solms and Pistia stratiotes L. Cultured in Nutrient Enriched Water.
W91-04986 2H

Urea Losses in Flooded Soils with Established Oxidized and Reduced Soil Layers.
W91-05554 3F

REDDY, S. L. N.
Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

REDLI, M.
Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

REES, Y. J.
Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

REEVE, A.
Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

REGIER, H. A.
Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

REGUNATHAN, P.
Precoat Carbon Filters as Barriers to Incidental Microbial Contamination.
W91-05709 5F

REID, I. K.
Instrumentation, Control and Automation in Water and Wastewater Management Elandsjagt Water Treatment Works.
W91-05286 5F

REILLY, J. F.
Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

REILLY, T. E.
Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

REIMOLD, R. J.
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

REINIUS, L. G.
Introduction of Deep Oxic/Anoxic Tanks at Hendriksdal Sewage Treatment Plant to Increase the Capacity.
W91-05505 5D

REISINGER, H. J.
Using Soil Vapor Contaminant Assessment at Hydrocarbon Contaminated Sites.
W91-05260 5B

REMY, B.
Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

RENGASAMY, P.
Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

REPLOGLE, J. A.
Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

REQUENA, F.
Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

RESH, V. H.
Hydrologic Influences, Disturbance, and Intraspecific Competition in a Stream Caddisfly Population.
W91-05202 2H

REYNOLDS, W. D.
Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

RIBA, P. E.
Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

RIBBE, J.
Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

RIBEIRO DE SOUSA, E.
Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

RIBEYRE, F.
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

RICE, S. D.
Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

RICH, R. R.
Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

RIDGEWAY, H. F.
Biodegradation of Dissolved Aromatic Hydrocarbons in Gasoline-Contaminated Groundwaters Using Denitrification.
W91-05253 5G

RIGGIO, R.
Precipitation in the Southern High Plains: Meteorologic and Isotopic Features.
W91-05866 2B

RIGONI-STERN, S.
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

RIM, J. M.
Competition and Inhibition of Sulfate Reducers and Methane Producers in Anaerobic Treatment.
W91-05732 5D

RINGHAND, H. P.
Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

RIORDAN, F.
Electrolytic Recovery of Mercury Metal from a Mercuric Chloride-Containing Waste.
W91-05685 5D

RIOS, A. F.
Water Interchange between the Ria of Vigo and the Coastal Shelf.
W91-05174 2L

RISEBROUGH, R. W.
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

RITCHIE, C. B.
Sewage Clarification with Magnetite Particles.
W91-05780 5D

RITTER, W. F.
Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

RITTMANN, B. E.
Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

RIVERA-SANTOS, J.
Parameter Estimation in Conceptual Precipitation-Runoff Models with Emphasis on Error Analysis.
W91-05621 2B

ROBB, M. M.
POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

ROBERTS, H. H.
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

ROBERTSON, S. D.
Tillage Effects on Sediment and Soluble Nutrient Losses from a Maury Silt Loam Soil.
W91-05399 5B

ROBERTSON, W. D.
Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

ROBINS, N. S.
Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

ROBINSON, M.
Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

ROBINSON, W. T.
Stabilized Petroleum Waste Interaction with Silty Clay Subgrade.
W91-05251 5G

RODRIGUE, P. B.
Rice and Furrow Irrigation Management.
W91-05159 3F

RODRIGUEZ, A.
Management of Sludge from Puerto Rico's Regional Industrial Wastewater Treatment Plant: Phase 2--Dewatering.
W91-05664 5D

ROELOFS, J. G. M.
Differential Tolerances Among Soft-Water Macrophyte Species to Acidification.
W91-05191 5C

ROGERS, C. W.
Updating the Smith-Feddes Model.
W91-05277 2B

ROGERS, K.
Community Demonstration of POU Systems Removal of Arsenic and Fluoride: San Ysidro, New Mexico.
W91-05715 5F

ROGERS, K. H.
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

ROGOWSKI, A. S.
Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

ROJARAYANONT, S.
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

ROLON-COLLAZO, L. I.
Development of an Aquifer Management Model: AQMAN3D.
W91-05616 4B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

ROLSTON, D. E.
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

ROMAN-SEDA, R. A.
Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

RONG, Y.
Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

ROSE, B. R.
Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

ROSE, C. W.
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: I. Rooting Patterns.
W91-05161 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

ROSE, J. B.
Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

ROSEN, J. D.
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

ROSENBAUM, S. W.
Hydrometallurgical Recycling of Metal Sludge.
W91-05686 5E

ROSENFELD, D.
Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

Second Israeli Rainfall Stimulation Experiment: Analysis of Precipitation on Both Targets.
W91-05856 3B

ROUT, J.
Comparative Assessment of Line Transect and Point Intercept Methods for Stream Periphyton.
W91-04997 2H

ROUTLEY, G. E.
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

ROWELL, D. L.
Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

ROWELL, H. C.
Chloride in the Pore Water and Water Column of Onondaga Lake, N.Y., U.S.A.
W91-04983 5B

ROZICH, A. F.
Formulating Strategies for Activated Sludge Systems.
W91-05036 5D

RUBEL, F. N.
Overview and Suggested Methodology to Determine the Adequacy of Cleanup of Contaminated Soils.
W91-05263 5G

RUBENSTEIN, C. B.
Heavy Metal Waste Conversion by Thermally-Driven Chemical Bonding.
W91-05684 5E

RUBIN, S.
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

RUDOLPH, D. L.
Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

RUS, E.
Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

RUSTEN, B.
Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

RYBAKOVA, N. A.
Water Permeability of Frozen Soils Under Tree Stands in the Forest-Steppe Zone.
W91-05233 2G

RYDER, R. A.
Clarification and Filtration to Meet Low Turbidity Reclaimed Water Standards.
W91-05808 5D

SAATCI, A.
Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

SAH, R. N.
Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

SAIKI, M. K.
Elemental Concentrations in Fishes from the Salton Sea, Southeastern California.
W91-04968 5B

SAITO, M.
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

SAKAI, S.
Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

SAKHAROVA, N. B.
Ice Conditions in Pools of the Dam of the Kolyma Hydroelectric Station during Initial Operation.
W91-05309 2C

SAL'NIKOV, V. G.
Nature and Mechanisms of Formation of Metal-Humus Complexes.
W91-05350 2G

SALBU, B.
Influences of Temperature on Aqueous Aluminum Chemistry.
W91-04977 2K

SALDANHA MATOS, J.
Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

SALEH, M. A.
Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

SALGADO, S. N.
Ground-Water Management Problems in the North Central Coast of Puerto Rico.
W91-05614 4B

SALICETI, L.
Optimization of Drinking Water Chlorination Practices for Minimization of Trihalomethanes Formation.
W91-05662 5F

SALIM, R.
Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

SAMSON, S. A.
Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

SANDBERG, K.
Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

SANTMARTI, M.
Development of a toxic Alexandrium minutum Halim (Dinophyceae) Bloom in the Harbour of Sant Carles de la Rapita (Ebro Delta, Northwestern Mediterranean).
W91-05171 5C

SANTOS, S. L.
Developing a Risk Communication Strategy.
W91-05020 5F

SAQQAR, M. M.
Microbiological Performance of Multi-Stage Stabilization Ponds for Effluent Use in Agriculture.
W91-05760 5D

SARKER, H.
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

SARMA, K. V. N.
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

SARMA, P. B.
Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

SAROFIM, A. F.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

SARTAIN, J. R.
Water Movement Through an Aggregated, Gravelly Oxisol from Cameroon.
W91-05889 2G

SASABE, K.
Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

SASAKI, K.
Characteristics of Melting Process for Sewage Sludge.
W91-05530 5E

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

SASINOS, F. I.
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

SASSEN, R.
Sea Floor Responses to Hydrocarbon Seeps, Louisiana Continental Slope.
W91-05916 5B

SATHE, V.
Effect of Lead, Mercury and Cadmium on a Sulphate-Reducing Bacterium.
W91-05391 5C

SATO, K.
Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

SATO, T.
Effects of Activated Sludge Properties on Water Flux of Ultrafiltration Membrane Used for Human Excrement Treatment.
W91-05769 5D

SAVICH, A. I.
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

SAVIGNY, K. W.
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

SAYEGH, G.
Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

SAYOK, A. K.
Hydrological Responses to Urbanization in Forested LaNana Creek Watershed Nacogdoches, Texas.
W91-05625 4C

SCANFERLATO, V. S.
Effects of Sediment-Associated Copper on Ecological Structure and Function of Aquatic Microcosms.
W91-04992 5C

SCARBOROUGH, R. W.
Soil Nitrate Profiles under Irrigation on Coastal Plain Soils.
W91-05129 5B

SCATENA, F. N.
Culvert Flow in Small Drainages in Montane Tropical Forests: Observations from the Luquillo Experimental Forest of Puerto Rico.
W91-05635 2E

SCHAUB, S. A.
Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

SCHERTZER, D.
Fractals, Raindrops and Resolution Dependence of Rain Measurements.
W91-05860 2B

SCHIAVON, M.
Study of Carbofuran Movement in Soils: Part I--Soil Structure.
W91-05902 5B

Study of Carbofuran Movement in Soils: Part II-Kinetics.
W91-05903 5B

SCHMIDLIN, T. W.
Critique of the Climatic Record of 'Water Equivalent of Snow on the Ground' in the United States.
W91-05859 2C

SCHMIDT, K. W.
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

SCHNEIDER, M. L.
User-Specific Water Demand Elasticities.
W91-05790 6D

SCHOCK, S. C.
Agricultural Chemicals in Rural, Private Water Wells in Illinois: Recommendations for a Statewide Survey.
W91-05280 5B

SCHOENEBERGER, P.
Directional Saturated Hydraulic Conductivity and Macropore Morphology of a Soil-Saprolite Sequence.
W91-05875 2F

SCHOLL, J. E.
Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

SCHOLL, M. A.
Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

SCHULZ, K. A.
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

SCHUTTE, C. E.
Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

SCHWINN, D. E.
Modifying Existing Activated Sludge Plants to Achieve Nitrification and Denitrification.
W91-05812 5D

SCOTT, R. F.
La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

SCOTT, W. K.
Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

SEBACHER, D. I.
Methane Emissions from the Florida Everglades: Patterns of Variability in a Regional Wetland Ecosystem.
W91-05017 2H

SEDDA, F. A.
Application of INAA and PIXE on the Analysis of Nutritional and Toxicological Elements in Samples of Drinkable Water.
W91-05899 5F

SEEGER, D. R.
Problems Associated with Analysis of Petroleum-Derived Materials in the Environment.
W91-05248 5A

SEIDEL, H.
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

SEIDEMANN, D. E.
Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

SEIP, H. M.
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

SEKOULOV, I.
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

SELLECK, R. E.
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

SEN, Z.
Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

SEPEDA, V.
Optimization of the Designs of Earth Dams.
W91-05083 8A

SEPULVEDA, N.
Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

SEQUI, P.
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

SERVE, L.
Tracers and Constituents Indicating the Nature of Organic Fluxes, Their Origin and the Effect of Environmental Conditions.
W91-05459 2L

SEWELL, G. W.
Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

SEXSTONE, A. J.
Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

SEYFRIED, C. R.
Advanced Wastewater Treatment by Means of Dry Bed Filters; Semi-Technical Test Results; Experiences on a Large-Technical Scale and Results.
W91-05506 5D

SHAFY, H. I.
Role of the Cement Industry in the Contamination of Air, Water, Soil and Plant with Vanadium in Cairo.
W91-04941 5B

SHAHALAM, A. B. M.
Evaluation of a Small Unsteady Continuous Flow RBC System.
W91-05206 5D

SHARMA, D. K.
Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

SHARMA, R. P.
Evaluation of Toluene Exposure via Drinking Water on Levels of Regional Brain Biogenic Monoamines and Their Metabolites in CD-1 Mice.
W91-05106 5C

SHARP-DAHL, J. L.
Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

SHARP, J. M.
Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

SHAW, J.
Evidence for Large-scale Subglacial Meltwater Flood Events in Southern Ontario and Northern New York State.
W91-05367 2E

SHAW, R. B.
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

SHAW, S.
Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

SHAYKEWICH, C. F.
Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

SHEER, D. P.
Climatic Sensitivity of California Water Resources.
W91-05793 6B

SHELEF, G.
Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

Role of Wastewater Reuse in Water Resources Management in Israel.
W91-05536 3C

SHERMAN, J. W.
Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

SHESTAKOV, V. G.
Degradation of Terbacil in Soil.
W91-05226 5B

SHI, M. C.
Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

SHIARIS, M. P.
Evidence Against Incorporation of Exogenous Thymidine by Sulfate-Reducing Bacteria.
W91-05588 2L

SHIELDS, F. D.
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

SHIH, T.-H.
What Shall We Do with Garbage-Dump and Landfill Leachate.
W91-05156 5G

SHIMIZU, K.
Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

SHIMIZU, N.
Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

SHIMOMURA, H.
Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

SHIN, K. S.
Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

SHINABE, K.
Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Pilot Plant Test of Electron-Beam Disinfected Sludge Composting.
W91-05527 5D

SHIPITALO, M. J.
Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

SHOGREN, J. F.
Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

SHOPLEY, J.
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

SHORT, J. W.
Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

SHOTYK, W.
Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

SHOVLIN, M. G.
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

SHUVAL, H. I.
Health Guidelines and Standards for Wastewater Reuse in Agriculture: Historical Perspectives.
W91-05535 5D

SHYAMASUNDARI, K.
Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

SILL, B. L.
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

SILVERMAN, D. N.
Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

SILVESTRI, V.
Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

SIMILA, A.
Seasonal Fluctuations in the Chemistry of Small Forest Lakes in Southern Finland with Special Reference to Acidity.
W91-05066 2H

SIMKISS, K.
Use of Chemical Analogues Such as Eu/Am in Ecotoxicological Studies.
W91-05047 5A

SIMPSON, R. D.
Incident of Southern Ocean Oil Pollution: Effects of a Spillage of Diesel Fuel on the Rocky Shore of Macquarie Island (Sub-Antarctic).
W91-05005 5C

SIMS, J. T.
Nitrogen Mineralization and Elemental Availability in Soils Amended with Cocomposted Sewage Sludge.
W91-05397 5E

SINGER, M. J.
Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

SINGER, P. C.
Chlorination of Humic Materials: Byproduct Formation and Chemical Interpretations.
W91-04946 5F

SINGH, A. K.
Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

SINGH, K. N.
Effect of Irrigation Scheduling on Growth, Yield and Evapotranspiration of Wheat in Sodic Soils.
W91-05935 3F

SINGH, M.
Effects of Soil-Cation Composition on Reactions of Four Herbicides in a Candler Fine Sand.
W91-04975 5B

SINGH, R.
Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

SINGH, V. N.
Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

SINGH, V. P.
Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

SINHA, S.
Removal of Cu and Cd from Water by Bacopa monnieri L.
W91-04980 5B

SKEHAN, S.
Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

SKIBA, S. I.
Methodological and Organizational Characteristics of Surveys for Small Hydroelectric Stations.
W91-05303 8C

SMITH, E. G.
Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

SMITH, G. A.
Biodegradation of Aromatic Hydrocarbons by Aquifer Microorganisms Under Denitrifying Conditions.
W91-05949 5G

SMITH, J. L.
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

SMITH, R. C. G.
Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

SMITH, R. E.
Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

SMITH, R. H.
Effects of Clearing and Snagging on Physical Conditions of Rivers.
W91-05141 4A

SMITH, V. J.
Probabilistic Soil Contamination Exposure Assessment Procedures.
W91-05326 5A

SMOLENSKY, D. A.
Particle Tracking Analysis of Recharge Areas on Long Island, New York.
W91-05822 5B

SNEVE, M. A.
Anaerobic Filter Treatment of Sulfate-Containing Wastewaters.
W91-05735 5D

SNOEIJS, P.
Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

SODEN, D. L.
Preferred Alternative Uses of Water Resources: Views of Environmental Activists in The U.S. Virgin Islands.
W91-05613 6D

SODERSTROM, M.
Toxicity Assessment by Pollution-Induced Community Tolerance (PICT), and Identification of Metabolites in Periphyton Communities after Exposure to 4,5,6-Trichloroguaiacol.
W91-05334 5C

SOEBERG, H.
Monitoring and Control of Biological Removal of Phosphorus and Nitrogen by Flow-Injection Analysers in a Municipal Pilot-Scale Waste-Water Treatment Plant.
W91-05331 5D

SOEDA, N.
Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

SOFER, S. S.
Comparison of Cadmium Biosorption by Gram-Positive and Gram-Negative Bacteria from Activated Sludge.
W91-05099 5D

SOMERVILLE, J. P.
Greater Cairo Wastewater Project.
W91-05804 5D

SOMMERFELD, A.
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

SOMMERFELD, R. A.
Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

SONG, Q.
DO Model Uncertainty with Correlated Inputs.
W91-05327 5B

SORENSEN, J. A.
Airborne Mercury Deposition and Watershed Characteristics in Relation to Mercury Concentrations in Water, Sediments, Plankton and Fish of Eighty Northern Minnesota Lakes.
W91-04951 5B

SORLINI, C.
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

SORNIN, J. M.
Nitrogenous Nutrient Transfers in Oyster Ponds: Role of Sediment in Deferred Primary Production.
W91-05589 2H

SOTELO, J. L.
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

SOULIE, M.
Laboratory Modelling of Field Permeability Tests in Cased Boreholes.
W91-05363 2F

Modelling Spatial Variability of Soil Parameters.
W91-05361 8D

SOUTHWORTH, G. R.
PCB Concentrations in Stream Sunfish (Lepomis auritus and L. macrochirus) in Relation to Proximity to Chronic Point Sources.
W91-04982 5B

SOUTHWORTH, W. P.
What is a Water Audit.
W91-05211 3D

SOWMAN, M.
Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

SOYER, J.
Particle Fluxes and Ecosystem Response on a Continental Margin: The 1985-1988 Mediterranean ECOMARGE Experiment.
W91-05450 2J

SPARKS, D. L.
Analyses of Adsorption Kinetics Using Stirred-Flow Chamber: II. Potassium-Calcium Exchange on Clay Minerals.
W91-05179 2K

Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

SPEECE, R. E.
Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

SPENCE, B. C.
Global Climate Change: Policy Implications for Fisheries.
W91-05167 8I

SPENCE, S. K.
Effects of TBT Contamination on Nucella Populations.
W91-05045 5C

SPENCER, D. F.
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

SPENCER, W.
Gas Exchange and Carbon Fixation Properties of the Mat-Forming Cyanophyte Lyngbya birgei G. M. Smith.
W91-04988 2H

SPILLMAN, M. F.
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

SPINOSA, L.
Cost Optimization of Sewage Sludge Filterpressing.
W91-05528 5D

SPIRIDONOV, Y. Y.
Degradation of Terbacil in Soil.
W91-05226 5B

SPOSITO, G.
Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

SRIVASTAVA, R.
Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

STACKHOUSE, R. A.
Influence of Dissolved Humic Materials on the Biological Effects of Drilling Components.
W91-05146 5C

STAKER, K. J.
Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

STANDARD, W. G.
Utility Financial Planning and Rate Design by Computer.
W91-05026 5D

STANLEY, D. R.
Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

STARR, D. O.
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

STARTSEV, A. D.
Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

STASKO, G. A.
Point-of-Entry Activated Carbon Treatment Lake Carmel--Putnam County.
W91-05714 5F

STAUFFER, R. E.
Alkalinities of Maine Lakes: Are They Really Changing.
W91-05579 2H

Controls on Surface Water Chemistry in the Southern Blue Ridge and Piedmont Provinces.
W91-04971 5B

STAUNTON, S.
Comparison of the Surface Impedance Factors of Ca, Na, Rb, and Cs Derived from Their Self-Diffusion Coefficients in Various Soils.
W91-05471 5B

STEENHUIS, T. S.
Numerical Model for Preferential Solute Movement in Structured Soils.
W91-05885 2G

Preferential Paths of Flow under Conventional and Conservation Tillage.
W91-05879 2G

STEIMLE, F. W.
Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

STENZEL, M. H.
Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

STEPHENS, R. D.
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

STEPHENSON, T.
Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

STERN, K.
Brief Review of Water Rights in New Hampshire.
W91-05213 6E

STERN, M. A.
Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

STERRITT, R. M.
Heavy Metal Binding by the Polymeric Organic Fractions of Sewage Sludges.
W91-05115 5E

STEVENS, A. B.
Use of a Digital Control System for Water Treatment and Management at Sappi's Enstra Mill.
W91-05298 5D

STEVENS, C. S.
Data Capture Systems at the Johannesburg Northern Works.
W91-05292 5D

STEVENS, T. G.
Monitoring and Maintenance Programs for POU/POE.
W91-05717 5F

STEVENSON, R. J.
Post-Spate Development of Epilithic Algal Communities in Different Current Environments.
W91-05190 2H

STEWART, M. H.
Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

STEWART, M. K.
Groundwater Dilution and Residence Times, and Constraints on Chloride Source, in the Mokai Geothermal System, New Zealand, from Chemical, Stable Isotope, Tritium, and 36-Cl Data.
W91-05570 2F

STEWART, M. T.
Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

STEWART, R. E.
Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

STEWART, T. L.
Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

STICKLE, W. B.
Imposex Induction in Nucella lima (Gmelin) via Mode of Exposure to Tributyltin.
W91-05054 5C

STOBER, J. A.
Subchronic Toxicity Study of Ozonate and Ozonated/Chlorinated Humic Acids in Sprague-Dawley Rats: A Model System for Drinking Water Disinfection.
W91-05951 5F

STOCKSTILL, R. L.
Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

STOJANOVIC, R. S.
Liquid Chromatography-Electrochemical Detection of Inorganic Arsenic Using a Wall Jet Cell with Conventional and Microsized Platinum Disk Electrodes.
W91-05093 5A

STOLARIK, G. F.
Power Evaluation of the Los Angeles Oxygen-Fed Ozone System.
W91-05057 5F

STOLPE, N. B.
Mineralogical Implications of High Ratios of 1500 kPa Water Content to Percent Measured Clay for Two Soils of Western Nebraska.
W91-05567 2G

STONE, A.
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

STONE, S. F.
Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

STORCH, T. A.
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

STORRS, H. W.
Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

STOUKIDES, M.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

STROBEL, D.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

STRONG, J. E.
Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

STROTHER, S.
Seasonal Changes in Standing Crop of Zostera muelleri in South-eastern Australia.
W91-05488 2L

STURDIVANT, R.
Groundwater Models of the Miocene Aquifer System in Jones County, Mississippi.
W91-05154 2F

STURGIS, T. C.
Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

STURTZ, J. D.
Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

SUBRAMANIAN, A. N.
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

SUCCARIEH, M. F.
La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

SUCHOMEL, K. H.
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

SUDARMANA, D. L.
Sewage Clarification with Magnetite Particles.
W91-05780 5D

SUDICKY, E. A.
Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

SUDO, R.
Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

SUGAWARA, Y.
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

SUGDEN, A.
Computerised Instrumentation and Control Systems.
W91-05293 7B

SUIDAN, M. T.
Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

Fed-Batch Technique to Evaluate Biodegradation Rates of Inhibitory Compounds with Anaerobic Biofilms Attached to Granular Activated Carbon.
W91-05741 5D

Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

SUKHOVA, S. N.
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

SUKSI, J.
Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

SULLIVAN, G. R.
Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

SUNDBACK, K.
Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

SUTHAKER, S.
Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

SUZUKI, M.
Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

SUZUKI, N.
Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

SUZUKI, Y.
239, 240-Pu and 137-Cs Concentrations in Some Marine Organisms, Mostly from the Ibaraki and Aomori Coasts, Japan, 1987-1989.
W91-05573 5B

Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

SUZUKI, Y.

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

SVARDAL, K.
Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

SVERDRUP, H.
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

SVINTSOV, A. I.
Water-Holding Capacity of Structures Made of Sand-Gravel-Pebble Soils.
W91-05078 8D

SVIRIDENOK, A. I.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

SWEETING, F. W.
On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

SWITZENBAUM, M. S.
Behavior of Carbon Monoxide as a Trace Component of Anaerobic Digester Gases and Methanogenesis from Acetate.
W91-04944 5D

SYAMALA, P.
Supercritical Flow in Smooth Open Channels.
W91-05422 8B

SYKES, M. C.
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

SZPYRKOWICZ, L.
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

SZYMURA, I.
Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

TADA, M.
Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

TAKAHASHI, M.
Application of Biotechnology to Municipal Wastewater Treatment.
W91-05499 5D

TAKAI, Y.
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

TAKAMIZAWA, K.
Effluent Pollution Control of Osaka North Port Dredged Soil Disposal Site (North Section-Site II and III).
W91-05771 5D

TAKAMURA, N.
Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

TAKASHIMA, M.
Effects of Heat Treatment on the High-Rate Anaerobic Digestion of Human Wastes Concentrates.
W91-05720 5D

TAKATSUKI, H.
Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

TAKAYANAGI, E.
Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

TAKEUCHI, Y.
Removal of Trihalomethane Precursors from River and Lake Water by Activated Carbon Adsorption.
W91-05778 5F

TALSMA, T.
Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: II. Water Uptake in Relation to Rooting Patterns.
W91-05162 2I

Tree/Pasture Interactions at a Range of Tree Densities in an Agroforestry Experiment: III. Water Uptake in Relation to Soil Hydraulic Conductivity and Rooting Patterns.
W91-05163 2G

TAMAURA, Y.
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

TAMBO, N.
Characteristics of Metal-Polysilicate Coagulants.
W91-05781 5F

TAN, C. S.
Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

TAN, K. H.
Geochemistry of Black Water in Selected Coastal Streams of the Southeastern United States.
W91-05562 2H

TANABE, S.
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

TANAKA, K.
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

Anaerobic Treatment of Thermal Sludge Conditioning Liquor and Characteristics of Granular Sludge Produced.
W91-05728 5D

Performance Analysis of the Rotating Biological Contactor Process Based on Particle Fraction and Improvement of Final Effluent Quality.
W91-05753 5D

Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

TANAKA, S.
Removal of Organic Constituents in Municipal Sewage Using Anaerobic Fluidized Sludge Blanket and Anaerobic Filter.
W91-05737 5D

TANAKA, S. S.
Risk Communication in Los Angeles: A Case Study.
W91-05019 5F

TANG, N. H.
Comparison of Serum Bottle Toxicity Test with OECD Method.
W91-05322 5D

TAPPARO, A.
Ion Chromatographic Determination of Trace Amounts of Aluminium with On-Line Preconcentration and Spectrophotometric Detection.
W91-05333 5A

TARAZONA, J. V.
Acute Toxicity to Freshwater Benthic Macroinvertebrates of Fluoride Ion (F-) in Soft Water.
W91-05010 5C

TARDY, Y.
Global World Propagation of Dryness and Wetness Waves (Propagation des Ondes de Secheresse et D'Humidite a Travers le Monde).
W91-04938 2B

TARRER, A. R.
Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

TASAKI, M.
Anaerobic Bacteria Degrading Low Molecular Chlorinated Fatty Acids and Related Compounds.
W91-05727 5D

TASHIRO, H.
Penetration of Biocides into Biofilm.
W91-05747 5D

TATSUKAWA, R.
Seasonal Variation of Persistent Organochlorine Insecticide Residues in Vellar River Waters in Tamil Nadu, South India.
W91-05388 5B

TAVENAS, F.
Permeability Anisotropy of Natural Clays as a Function of Strain.
W91-05359 8D

TAYLOR, B. D.
Environmental Regulations Place New Responsibilities on Property Owners.
W91-05237 5G

TAYLOR, B. E.
Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

TAYLOR, J. B.
Portland Water District's Water Distribution Master Plan.
W91-05210 5F

TAYLOR, M. D.
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

TAYLOR, V.
Laboratory Reclamation Study for Sodic Soils Used for Rice Production.
W91-05933 5G

TAYLOR, W. D.
Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

TAZIK, D. J.
U.S. Army Land Condition/Trend Analysis of the Pohakuloa Training Area, Hawaii.
W91-05657 4C

TCHOBANOGLOUS, G.
Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

TEAL, J. M.
Influence of Mode of Exposure and the Presence of a Tubiculous Polychaete on the Fate of Benz(a)anthracene in the Benthos.
W91-04945 5B

TEL, D. A.
Chloride Analyses of Soil Leachate Using the TRAACS 800 Analyzer.
W91-05560 5A

TELIS, P. A.
Improving Estimates of Low-flow Characteristics for Streamflow Stations Affected by Climatic Cycles.
W91-05140 2E

TENNABT, P. A.
Improving Strategies for Chemical Spills.
W91-05035 5G

TEPLITSKAYA, T. A.
Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

TERANISHI, S.
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

TERHELL, J. C.
Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

TETRADZE, T. L.
Refinement of the Engineering-Geological Conditions of the Foundation of the Khudoni Arch Dam.
W91-05313 8E

THALER, J. S.
Hudson Basin Precipitation Regimes: Croton, Esopus, and Schoharie Watersheds.
W91-05796 2B

THEISEN, K.
Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

THENE, J. R.
Gas-Transfer Measurements Using Headspace Analysis of Propane.
W91-05324 7B

THINH, T. V.
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

THOMAS, G. L.
Effect of Canopy Formation by Floating and Submergent Aquatic Macrophytes on the Water Quality of Two Shallow Pacific Northwest Lakes.
W91-04989 2H

THOMAS, J. C.
Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

THOMAS, M.
Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

THOMAS, M. P.
Question of Nitrates.
W91-05904 5B

THOMAS, W. M.
Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

THOMSEN, R.
Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

THURTELL, G. W.
Humidity and Soil Water Influence the Transpiration Response of Maize to CO2 Enrichment.
W91-05557 2D

TIEFENBRUNNER, F. H.
Ozone Treatment of Small-Size Swimming Pools and Whirlpools.
W91-05059 5F

TIETJEN, J. H.
Population Growth and Effects of Nematodes on Nutrient Regeneration and Bacteria Associated with Mangrove Detritus from Northeastern Queensland (Australia).
W91-05594 2H

TILLES, R. S.
Selection of the Composition of Roller-Compacted Concretes.
W91-05080 8F

TILLITT, D. E.
Characterization of the H4IIE Rat Hepatoma Cell Bioassay as a Tool for Assessing Toxic Potency of Planar Halogenated Hydrocarbons in Environmental Samples.
W91-05950 5A

TIMOFEYEV, B. V.
Formation and Physical State of Leached Ferrallitic Savanna Soils of Mali.
W91-05215 2J

TITUS, J. G.
Greenhouse Effect and Coastal Wetland Policy: How Americans Could Abandon an Area the Size of Massachusetts at Minimum Cost.
W91-05905 2B

TOBIN, R. S.
Control of Point-of-Use Water Treatment Devices in Canada: Legal and Practical Considerations.
W91-05697 5F

TOGNOTTI, L.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

TOKUNAGA, S.
Analysis of Dewatering Characteristics of Lake and River Sediments.
W91-05525 5G

TOLONEN, K.
Paleolimnological Investigation of the Eutrophication History of Lake Tuusulanjarvi, Southern Finland.
W91-05062 5C

TOMATI, U.
Indolacetic Acid Production from Olive Waste Water by Arthrobacter spp.
W91-05483 5E

TOMCZAK, M.
Impact Assessment for the French Nuclear Weapon Test Sites in French Polynesia.
W91-05347 5B

TOMINAGA, A.
Turbulent Structure in Compound Open-Channel Flows.
W91-05420 8E

TOMITA, Y.
Basic Study of the Efficiency of Spiral Flow Aeration.
W91-05523 5D

TONIATII, N. B.
Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

TOPPER, K.
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

TORANZOS, G. A.
Isolation of Bacteriophages from Large Volumes of Pristine Tropical Waters and Their Correlation to Fecal Contamination.
W91-05666 5A

Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

Utilization of Intracellular Granules of INT-Formazan and Gene Probes for Tracing Microorganisms in Ground Water.
W91-05661 5B

TORREGROSSA, M.
Modified Most-Probable-Number Technique for the Specific Determination of Escherichia coli from Environmental Samples using a Fluorogenic Method.
W91-05572 5A

TORRES, A. P.
Removal of Barium Ion from Solution Using Datura innoxia Mill. Suspension Culture Cells.
W91-05393 5D

TORRES-GONZALEZ, S.
Computer Program for Geophysical Log Data Management and Plotting (GEOMAN).
W91-05651 7B

Interactive Computer Program MODUMANAG, A Data Management Tool for the Modular Finite-Difference Ground-Water Flow Model.
W91-05652 2F

TORRES-SANCHEZ, A. J.
Rainfall-Soil Moisture Relations in Landslide-Prone Areas of a Tropical Rain Forest, Puerto Rico.
W91-05624 2A

TRAEGNER, U. K.
Steady State Performance of Activated Carbon Contactors.
W91-05777 5D

TRAPP, L.
Wisconsin Regulation of Point-of-Use and Point-of-Entry Water Treatment Devices.
W91-05699 5F

TREGUB, G. A.
Steam Fogs in Lower Pools of Hydroelectric Stations and Possibilities of Their Artificial Dispersion.
W91-05312 2C

TREHY, M. T.
Determination of Linear Alkylbenzenesulfonates and Dialkyltetralinsulfonates in Water and Sediment by Gas Chromatography/Mass Spectrometry.
W91-05092 5A

TRIET, L. M.
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

TRIFEL, M. S.
Ways to Increase the Service Life of Metal Members of Hydraulic Structures.
W91-05085 8G

TRIMBLE, S. P.
Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

TRINET, F.
Study of Biofilm and Fluidization of Bioparticles in a Three-Phase Liquid-Fluidized-Bed Reactor.
W91-05742 5D

TROPE, J. I.
pH & RH Control in Metal Surface Treatment Recovery System.
W91-05297 5D

TRUBY, P.
Heavy-Metal Uptake from the Freiburg Wastewater Field by Garden Vegetables (Schwermetallaufnahme von Gartenpflanzen der Freiburger Rieselfelder).
W91-05474 5E

TRUMAN, C. C.
Antecedent Water Content and Rainfall Energy Influence on Soil Aggregate Breakdown.
W91-05184 2J

TRUSCOTT, R.
Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

TRZHTSINSKII, Y. B.
Effect of Siberian Reservoirs on the Environment.
W91-05302 4A

TSAI, C. S.
Method of Transient Analysis of Three-Dimensional Dam-Reservoir Interactions.
W91-05124 8B

TSELISHCHEVA, L. K.
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

TSIRD, K.
Polycyclic Aromatic Hydrocarbons in Leached Chernozems and Gray Forest Soils of Natural and Technogenic Landscapes.
W91-05575 5B

TSUDA, R.
Spectral Distribution Characteristics in Downwelling Irradiance and Optical Properties within the Euphotic Layer in the North Basin of Lake Biwa.
W91-04996 2H

TSUNEMI, T.
Sludge Melting Process with Hazardous Asbestos Wastes.
W91-05531 5E

TUBINO, M.
Growth of Alternate Bars in Unsteady Flow.
W91-05835 2J

TUCK, S.
Simulation of Hydrochemistry in a Highland Scottish Catchment Using the Birkenes Model.
W91-04978 2K

TUMEO, M. A.
Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

TURNER, R. M.
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

TURPEN, S. L.
Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

TUTHILL, R. W.
Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

TYAGI, B. S.
Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

UCHRIN, C. G.
Laboratory and In-Situ Sediment Oxygen Demand Determinations for a Passaic River (NJ) Case Study.
W91-05208 5B

UCHVATOV, V. P.
Geochemical Flows of Microelements in Agricultural Landscapes of the Central European USSR.
W91-05828 2J

UDELL, M. D.
Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

UKHOV, S. B.
Effect of Dilatancy of Rocks on Resistance to Shearing Loads.
W91-05077 8E

ULMER, R. L.
Tennessee-Tombigbee Waterway Canal Section Effect on Adjacent Bottomland Hardwoods.
W91-05147 6G

UMITA, T.
Biological Oxidation of Ferrous Iron in High Acid Mine Drainage by Fluidized Bed Reactor.
W91-05752 5D

UNNY, T. E.
Impacts of Meteorological Variations on Acid Rain Abatement Decisions.
W91-05321 5B

UREN, N. C.
Effect of Sulphur Dioxide on Extractable Manganese in Soils.
W91-05339 5B

US'YAROV, O. G.
Comparison of Models of Phosphate Sorption by Soils.
W91-05231 2K

UTERMANN, J.
Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

VACHER, H. L.
Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

VADAS, G. G.
Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

VALE, C.
Organochlorine Compounds in the Portuguese Oyster: Importance of Seasonal Variations.
W91-05348 5B

VALOCCHI, A. J.
Use of Temporal Moment Analysis to Study Reactive Solute Transport in Aggregated Porous Media.
W91-05887 2G

VAN BEELEN, P.
Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

VAN BUUREN, J. C. L.
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

VAN DAM, J. C.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

VAN DE HAAR, J.
Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

VAN DER VLUGT, J. C.
Impact of Eutrophication on the Silicate Cycle of Man-Made Basins in the Rhine Delta.
W91-04959 5C

Reeuwijk Lakes: A Five Years Water Quality Study in an Eutrophic Ecosystem.
W91-04962 5C

VAN DEVENDER, T. R.
Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

VAN DYKE, K.
Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

VAN EEDEN, P.
Continuous Water Quality Monitoring.
W91-05287 5G

VAN EMMERICK, P.
Advances in Face Slab Construction Techniques for CFRDs.
W91-05118 8F

VAN GENUCHTEN, M. T.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

VAN KEULEN, F.
Kinetics of the Degradation of Chloroform and Benzene in Anaerobic Sediment from the River Rhine.
W91-04958 5B

VAN LEEUWEN, H. L. J. M.
Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

VAN OMMEN, H. C.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

VAN RHEINECK LEYSSIUS, H. J.
Regional Scale Model for the Calculation of Episodic Concentrations and Depositions of Acidifying Components.
W91-04984 5B

VAN ZANTEN, B.
Phases in the Development of Riverine Plankton: Examples from the Rivers Rhine and Meuse.
W91-04961 5C

VAN ZYL, J. M.
Equations to Calculate the Approximate Duration and Termination of the Maximal Rate Phase of Nitrification in Soil.
W91-05342 5B

VARIS, O.
Modeling of Water Quality in Lake Tuusulanjarvi.
W91-05063 5G

VARUNTANYA, C. P.
Thermal Desorption of Hazardous and Toxic Organic Compounds from Soil Matrices.
W91-05256 5G

VATERLAUS, H. P.
Piezoelectric Quartz Crystal Water Level Measurement.
W91-05120 8G

VAUCLIN, M.
Water Balance Estimation Model: Field Test and Sensitivity Analysis.
W91-05183 2G

VAZQUEZ, F.
Trace and Heavy Metals in the Oyster Crassostrea virginica, San Andres Lagoon, Tamaulipas, Mexico.
W91-05014 5B

VAZQUEZ, M.
Geographic Distribution of Drought on Two Caribbean Islands: Puerto Rico and St. Kitts.
W91-05626 2E

VEARIL, J.
Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

VECCHIOLI, G. I.
Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

VELASQUEZ, Z. R.
Nutrients and Phytoplankton in the Gulf of Lions, Northwestern Mediterranean.
W91-05455 2H

VELLIOGLU, S. G.
Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

VENUGOPAL, N. B. R. K.
Fluoride Induced Changes in Protein Metabolism in the Tissues of Freshwater Crab Barytelphusa guerini.
W91-05109 5C

VERHAEGHE, I.
Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

VERMA, H. N.
Design of Storage Tanks for Water Harvesting in Rainfed Areas.
W91-05930 8A

VIET, N. T.
Application of Three Step-Biological Pond with the Use of Aquatic Plant for Post Treatment of Petroleum Wastewater in Vietnam.
W91-05758 5D

VIGNESWARAN, S.
Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

VIITASAARI, M.
Rural Water Supply Development in Finland: Possible Implications for the Developing Countries.
W91-05060 5F

VILLA, M.
Anaerobic Digestion of Wastes Containing Pyrolignitic Acids.
W91-05845 5D

VILLENEUVE, J.-P.
Flux of Transuranium Nuclides and Chlorinated Hydrocarbons in the Northwestern Mediterranean.
W91-05457 5B

VISWANATHAN, M. N.
Biological Removal of Iron from Groundwater.
W91-05751 5F

VLUGMAN, A. A.
Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

VOGEL, C. H.
Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

VOIGT, R. L.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

VON KUSTER, T.
Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

VON WANDRUSZKA, R. M. A.
Fluorescence Quenching and Polarization Studies of Naphthalene and 1-Naphthol Interaction with Humic Acid.
W91-05180 5B

VONDRACEK, J. E.
Ferrous Foundry Waste Minimization Options.
W91-05677 5G

VROBLESKY, D. A.
Mapping Zones of Contaminated Ground-Water Discharge Using Creek-Bottom-Sediment Vapor Samplers, Aberdeen Proving Ground, Maryland.
W91-05813 5B

VUGTS, H. F.
Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

VYSOCHENKO, A. V.
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

WADA, H.
Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

WADE, N. M.
Likelihood of Significant Cost Reductions in Desalination.
W91-05193 3A

WAGNER, J.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

WAGNER, M.
Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

WALBADET, E.
Decametric Variability of Soudano-Sahelian Rainfall Fields (Variabilite Spatiale des Precipitations Soudano-Saheliennes a l'Echelle Decametrique).
W91-05850 2B

WALKER, B. H.
Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

WALKER, C. H.
Kinetic Models to Predict Bioaccumulation of Pollutants.
W91-05038 5B

Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

WALKER, R. B.
Ground Water Seepage in the Indian River Lagoon, Florida.
W91-05648 2F

WALKER, T. A. B.
Modelling Stream Acidification in Afforested Catchments: An Assessment of the Relative Effects of Acid Deposition and Afforestation.
W91-05437 5C

Modelling Stream Acidification in Afforested Catchments: Long-Term Reconstructions at Two Sites in Central Scotland.
W91-05436 5C

WALKER, W. R.
Transient Hydraulic Modeling for Improved Canal System Operation.
W91-05929 3F

WALL, J. H.
New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

WALLEN, D. G.
Toxicity of Chromium (VI) to Photosynthesis of the Phytoplankton Assemblage of Lake Erie and the Diatom Fragilaria crotonensis Kitton.
W91-05486 5C

WALLIS, T. N.
Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

WALTERS, J. V.
What Can You Learn about Water Resources in Moscow, U.S.S.R.
W91-05151 6E

WALTON-DAY, K.
Mechanisms Controlling Cu, Fe, Mn, and Co Profiles in Peat of the Filson Creek Fen, Northeastern Minnesota.
W91-05050 2K

WANG, C.
Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

WANG, G. T.
ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

WANG, J. R.
Retrieval of Water Vapor Profiles from Microwave Radiometric Measurements near 90 and 183 GHz.
W91-05854 2B

WANG, J. S. Y.
Fluid Flow in Partially Saturated, Welded-Nonwelded Tuff Units.
W91-05883 2F

WANG, Q.
Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

WANG, Q. J.
Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

WANG, X.
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

WANNER, O.
Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
W91-05744 5D

WARD, G. D.
Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

WARFVINGE, P.
Role of Weathering and Forestry in Determining the Acidity of Lakes in Sweden.
W91-04970 5B

WARRICK, A. W.
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

WASH, C. H.
Snow/Cloud Discrimination with Multispectral Satellite Measurements.
W91-05853 2B

WASKOM, R. M.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

WASSENAAR, L. I.
Organic Carbon Isotope Geochemistry of Clayey Deposits and Their Associated Porewaters, Southern Alberta.
W91-05441 2G

WATANABE, Y.
Biofilm Properties and Simultaneous Nitrification and Denitrification in Aerobic Rotating Biological Contactors.
W91-05743 5D

WATERHOUSE, K. S.
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

WATSON, B. M.
Membrane Softening: The Concept and Its Application to Municipal Water Supply.
W91-05194 5F

WATSON, P. G.
Multilevel, In Situ Pore-Water Sampler for Use in Intertidal Sediments and Laboratory Microcosms.
W91-05586 7B

WATTS, R. J.
Treatment of Pentachlorophenol-Contaminated Soils Using Fenton's Reagent.
W91-05919 5D

WAVROCK, P.
Waste Minimization of Hazardous Waste Solutions in the Electroplating and Precious Metals Industry Using the Final Treatment Distillation Unit.
W91-05681 5D

WAX, C. L.
Substituting Climate for Groundwater in Aquaculture: The Potential for Conservation in the Southeastern United States.
W91-05157 3F

WAYLEN, P. R.
Annual and Seasonal Fluctuations of Precipitation and Streamflow in the Aconcagua River Basin, Chile.
W91-05432 2B

WEBB, J. W.
Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

WEBER, R. E.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

WEBSTER, G. R.
Evidence of Sensitized Photolysis of Polychlorinated Dibenzo-p-Dioxins in Natural Waters under Sunlight Conditions.
W91-04954 5B

WEBSTER, R. P.
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

WEEMEES, I.
Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

WEI, H. F.
Regional Modelling of Groundwater Flow and Salt and Environmental Tracer Transport in Deep Aquifers in the Paris Basin.
W91-05447 2F

WEIDEMANN, G.
Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

WEIJERS, E. P.
Observational Study on Precipitation Chemistry Data as a Function of Surface Wind Direction.
W91-04973 5B

WEIL, R. R.
Nitrogen Status of Forest Floor, Soils, and Vegetation Following Municipal Wastewater Sludge Application.
W91-05400 5E

WEINER, R. M.
Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

WEINMAN, J. A.
Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

WELTERLEN, M. S.
Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

WELTEVREDE, R.
Large Scale Anaerobic-Aerobic Treatment of Complex Industrial Waste Water Using Biofilm Reactors.
W91-05750 5D

WENGER, R. B.
Framework for Incorporating Stream Use in the Determination of Priority Watersheds.
W91-05386 6D

WERSHAW, R. L.
Detection of Poly(ethylene glycol) Residues from Nonionic Surfactants in Surface Water by 1H and 13C Nuclear Magnetic Resonance Spectrometry.
W91-05956 5A

WESTERMAN, P.W.
Long Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: I. Yield, Quality, and Element Removal.
W91-05405 5D

Long-Term Swine Lagoon Effluent Applications on 'Coastal' Bermudagrass: II. Effect on Nutrient Accumulation in Soil.
W91-05406 5E

WHEATON, F. W.
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

WHICKER, F. W.
Distribution of Long-Lived Radionuclides in an Abandoned Reactor Cooling Reservoir.
W91-05200 5B

WHITE, K. N.
Influence of Metal and Temperature Stress on the Immune System of Crabs.
W91-05049 5C

WHITEHOUSE, B. G.
Cross-Flow Filtration of Colloids from Aquatic Environments.
W91-05585 5A

WHITLATCH, E. E.
User-Specific Water Demand Elasticities.
W91-05790 6D

WICHELNS, D.
Potential Economic Returns to Improved Irrigation Infiltration Uniformity.
W91-05934 3F

WIERENGA, P. J.
Variability of Soil Water Tension and Soil Water Content.
W91-05925 2G

WIGHTMAN, M. J.
Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

WILCOCK, D. N.
Checks on the Measurement of Potential Evapotranspiration Using Water Balance Data and Independent Measures of Groundwater Recharge.
W91-05430 2D

WILD, S. R.
Organic Contaminants in an Agricultural Soil with a Known History of Sewage Sludge Amendments: Polynuclear Aromatic Hydrocarbons.
W91-04949 5E

WILDERER, P. A.
Phosphate Removal in a Biofilm Reactor.
W91-05748 5D

WILHELM, K.
DHS Waste Reduction Program.
W91-05670 5G

WILHELM, R. W.
Assessment and Remediation of Residential Properties Contaminated with Home Heating Oil: Case Studies.
W91-05262 5G

WILKINS, J. P. G.
Polychlorinated Biphenyls in Extracts of Brain from Manx Shearwaters.
W91-05007 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--I. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Razorbills (Alca tarda) of British and Irish Coastal Waters.
W91-05941 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--II. Molecular Features of PCB Isomers and Congeners in Adipose Tissue of Male and Female Puffins (Fratercula arctica), Guillemots (Uria aalga), Shags (Phalacrocorax aristotelis) and Cormorants (Phalacrocorax carbo) of British and Irish Coastal Waters.
W91-05942 5B

Polychlorinated Biphenyls (PCBs) in Fish-Eating Sea Birds--III. Molecular Features and Metabolic Interpretations of PCB Isomers and Congeners in Adipose Tissues.
W91-05943 5B

WILLEMSEN, A.
Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

WILLEN, T.
Absence of Allelopathic Effects of Chara on Phytoplankton In Situ.
W91-04990 2H

WILLIAMS, J. E.
Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

WILLIAMS, R.
Water Quality Problems of Rural Communities in Puerto Rico--A Case Study.
W91-05667 5F

WILMUT, C. G.
Sludge Made Manageable with Wedgewater Filter Beds.
W91-05030 5D

WILSON, B. L.
Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

WILSON, C. A.
Fishery-Dependent Based Study of Fish Species Composition and Associated Catch Rates Around Oil and Gas Structures off Louisiana.
W91-05460 8I

WILSON, G. V.
Hydrology of a Forested Hillslope During Storm Events.
W91-05881 2G

Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

Unsaturated Solute Transport Through a Forest Soil During Rain Storm Events.
W91-05880 2G

WIMBERLY, P. M.
Anchoring a Dam.
W91-05069 8A

WIN, K. M.
Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

WINCHESTER, J. W.
Soluble Metals in the Atmosphere and Their Biological Implications: A Study to Identify Important Aerosol Components by Statistical Analysis of PIXE Data.
W91-05894 5C

WINDELL, J. T.
Compatibility of Stream Habitat Reclamation with Point Source and Nonpoint Source Controls.
W91-05802 5G

WINSTON, J.
Federal Trade Commission Regulation of Water Treatment Devices.
W91-05701 5F

WINTER, J. D.
Toxicity of Chautauqua Lake Bridge Runoff to Young-of-the-Year Sunfish (Lepomis macrochirus).
W91-05016 5C

WITKOWSKY, A.
Microphytobenthic Cell Density and Species Composition in the Surface Sediment in a Shallow Brackish-Water Bay (Gulf of Finland).
W91-05067 2H

WOLFE, R. L.
Assessment of the Bacteriological Activity Associated with Granular Activated Carbon Treatment of Drinking Water.
W91-05097 5F

WOLFF, D. B.
Climatologically Tuned Reflectivity-Rain Relations and Links to Area-Time Integrals.
W91-05858 2B

WOLFF, F.
Environmental Assessment of Human Interference on the Natural Processes Affecting the Barrier Beaches of Long Island, New York.
W91-05797 4C

WOLMAN, M. G.
Impact of Man.
W91-05872 4C

WONG, K.-C.
Lagrangian Motions in Simple Kinematic Oscillatory Flow Field.
W91-05784 8B

WONG, M. T. F.
Retarded Leaching of Nitrate in Acid Soils from the Tropics: Measurement of the Effective Anion Exchange Capacity.
W91-05472 5B

WOO, H. J.
Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

WOO, M.-K.
Studies of a Subarctic Coastal Marsh. III. Modelling the Subsurface Water Fluxes and Chloride Distribution.
W91-05427 2H

WOODRUFF, P. H.
Pennsylvania's Water Quality: How Far We Have Come, How Far We Have to Go.
W91-05810 6B

WOOLRIDGE, G. I.
Comparison of Estimates of Snow Input with a Small Alpine Catchment.
W91-05444 2C

WORSFOLD, P. J.
On-line Determination of Residual Aluminium in Potable and Treated Waters by Flow-Injection Analysis.
W91-05330 5A

WORTELBOER, F. G.
Model on the Competition Between Two Macrophyte Species in Acidifying Shallow Soft-Water Lakes in the Netherlands.
W91-04964 5C

WU, W.-T.
Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

WUELLNER, A. M.
Anaerobic Treatment of a High-Strength Industrial Waste Bearing Inhibitory Concentrations of 1,1,1-Trichloroethane.
W91-05746 5D

XU, X.
Supercritical Fluid Extraction of Coal Tar Contaminated Soil.
W91-04953 5G

YADAVA, K. P.
Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

YAMADA, M.
Sewage Sludge Composting Process by Static Pile Method.
W91-05526 5E

YAMAGUCHI, T.
Denitrification in Porous Media During Rapid, Continuous Leaching of Synthetic Wastewater at Saturated Water Flow.
W91-05398 5D

Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

YAMAMOTO, K.
Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

YAMAMOTO, M.
Reagentless-Continuous Flow Method for Determination of Aqueous Ozone with Thin Film Semiconductor and Application to an Advanced Water Treatment Plant.
W91-05524 5F

YAN, L.
La Villita Dam Response During Five Earthquakes Including Permanent Deformation.
W91-05125 8E

YANEZ, H.
Simulation of Flood Waves from Outburst of Glacier-Dammed Lake.
W91-05421 2E

YARON, B.
Effect of Volatilization on the Mass Flow of a Non-Aqueous Pollutant Liquid Mixture in an Inert Porous Medium: Experiments with Kerosene.
W91-05470 5B

YASHIKI, D.
Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

YASUDA, Y.
Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

YASUNO, M.
Influence of Persistence Period of an Insecticide on Recovery Patterns of a Zooplankton Community in Experimental Ponds.
W91-05110 5C

Primary Production of Epiphytic Algae and Phytoplankton in the Littoral Zone of Lake Kasumigaura.
W91-05596 2H

YAVITT, J. B.
Methane Fluxes in Wetland and Forest Soils, Beaver Ponds, and Low-Order Streams of a Temperate Forest Ecosystem.
W91-05865 5B

YEGIAN, M. K.
Earthquake-Induced Permanent Deformations: Probabilistic Approach.
W91-05869 8A

Seismic Risk Analysis for Earth Dams.
W91-05868 8A

YEH, W. W.-G.
Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

YEN, B. C.
Optimal Design for Storm Sewer System with Pumping Stations.
W91-05787 5D

YI, Q.
Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

YIBO, W.
Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

YODA, M.
Pilot and Full-Scale Experience in Anaerobic Treatment of Brewer's Yeast Processing Wastewater.
W91-05723 5D

YOHANNES, B. W.
Implementation of a Heavy Metals Reduction Program in the City of Los Angeles.
W91-05673 5G

YOKOSI, S.
Using Breakthrough Curves for Parameter Estimation in the Convection-Dispersion Model of Solute Transport.
W91-05600 2G

YOON, Y. Y.
Environmental Research on Trace Elements in Freshwater Fish by Neutron Activation Analysis.
W91-05897 5B

YOSHIDA, H.
Recovery of Direct Dye and Acid Dye by Adsorption on Chitosan Fiber-Equilibria.
W91-05776 5D

YOSHIDA, T.
Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

YOUNG, G. L.
Influence of Greentree Reservoir Management on Overstory Composition, Canopy Density, and Hardwood Regeneration on Noxubee National Wildlife Refuge.
W91-05149 6G

YOUNG, R.
Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

YOUNGHANS-HAUG, C.
PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

YOUNGS, E. G.
Aspects of Transport Processes in Aggregated Soils.
W91-05473 5B

YU, F. X.
Derivation of Infiltration Equation Using Systems Approach.
W91-05136 2G

YU, Y. S.
ARMA Model for Rainfall-Runoff with Applications.
W91-05620 2B

YUDKEVICH, A. I.
Results of On-site Observations of Landslide Slopes of the Zagorsk Pumped-Storage Station and Reliability of Geological Forecasts.
W91-05306 8D

YUHEI, I.
Denitrification of Landfill Leachate by the Modified Rotating Biological Contactor (RBC).
W91-05755 5D

YUKI, Y.
Design of Multi-Story Sewage Treatment Facilities.
W91-05500 5D

YUMET, G. M.
Removal of Giardia spp. by Conventional Water and Sewage Treatment Processes and Presence of Cysts in Surface Waters of Puerto Rico.
W91-05665 5D

YUSUPOV, D. A.
Calculations of Swinging of the Flow in Trapezoidal Channels.
W91-05314 8B

ZACHMANN, J. E.
Earthworm Effects on Corn Residue Breakdown and Infiltration.
W91-05609 2G

ZACK, A. L.
Laboratory Simulation of the Effects of Overburden Stress on the Specific Storage of Shallow Artesian Aquifers.
W91-05646 2F

ZAFIRIOU, O. C.
Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

ZAHN, R. K.
DNA Damage Determination by the Alkaline Elution Technique in the Haemolymph of Mussel Mytilus galloprovincialis Treated with Benzo(a)pyrene and 4-Nitroquinoline-N-oxide.
W91-04991 5C

ZANGRANDO, F.
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

ZAPATA LOPEZ, R. E.
Using Common Sense to Prevent Soil Erosion from Urban Development Areas.
W91-05619 4D

ZARETSKII, Y. K.
Calculated Prediction of Earth Pressures on Tailwater Tunnels of the Rogun Hydroelectric Station.
W91-05076 8E

ZASOBA, V. V.
Soil Conservation Functions of Steppe Forest Plantations.
W91-05221 4D

ZBORISHCHUK, N. G.
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

ZDANOWICZ, V. S.
Metals and Organic Contaminants in Northwest Atlantic Deep-sea Tilefish Tissues.
W91-05346 5B

ZEISLER, R.
Instrumental Neutron Activation Analysis of Standard Reference Material 1941, Organics in Marine Sediment.
W91-05900 5A

ZELAZNY, L. W.
Physical and Chemical Controls of Preferred Path Flow Through a Forested Hillslope.
W91-05882 2G

ZELEZNIK, J. M.
Mechanism of Water Entry into Simulated Macropores.
W91-05599 2G

ZENOVA, G. M.
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

ZEYLIGER, A. M.
Heuristic Model of Pore Space for Imitation of Moisture-Transport in Structured Soils.
W91-05352 2G

ZGHEIB, P. W.
Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

ZHANG, J.
Concentration and Partioning of Particulate Trace Metals in the Changjiang (Yangtze River).
W91-04969 5B

Huanghe (Yellow River) and Its Estuary: Sediment Origin, Transport and Deposition.
W91-05439 2J

Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

ZHANG, P.
Kinetics of Selenate and Selenite Adsorption/Desorption at the Goethite/Water Interface.
W91-05075 5B

ZHANG, P. C.
Kinetics and Mechanisms of Sulfate Adsorption/Desorption on Goethite Using Pressure-Jump Relaxation.
W91-05178 2K

ZHANG, S.
Pattern of Particulate Nitrogen Transport in World Rivers.
W91-05018 5B

ZHANG, T. C.
Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
W91-05722 5D

ZHONGXIANG, Z.
Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

ZHOU, M. Y.
Chemical Analysis of Rain Samples Collected over the Pacific Ocean.
W91-05862 2K

ZHUANG, Y.
Study and Application of Rainfall-Runoff Model for Karst Regions.
W91-05623 2A

ZILBERMAN, D.
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

ZILIO GRANDI, F.
Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

ZILLIOX, L.
Miscible Displacement with Density and Viscosity Contrasts. Estimation of Displacement Parameters and Stability in Mechanical Dispersion Regime (Deplacement Miscible Avec Contrastes de Densite et de Viscosite en Milieu Poreux. Identification des Parametres de Deplacement et Stabilite en Regime de Dispersion Mecanique).
W91-05435 5B

ZIMMERMAN, E. G.
Potential Effects of Global Warming on Native Fishes of the Southern Great Plains and Southwest.
W91-05166 2B

ZUKOWSKI, M. D.
Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

ZVYAGINTSEV, D. G.
Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

ZWEIFELHOFER, H. P.
Effects of Aerobic Thermophilic Pretreatment.
W91-05807 5D

ORGANIZATIONAL INDEX

AALBORG UNIVERSITETSCENTER (DENMARK). ENVIRONMENTAL ENGINEERING LAB.
Sulfur Sources for Hydrogen Sulfide Production in Biofilms from Sewer Systems.
W91-05733 5D

AARHUS COUNTY DEPT. OF THE ENVIRONMENT, HOEJBJERG (DENMARK).
Effect of Climate Variability and Change in Groundwater in Europe.
W91-05382 2B

AARHUS UNIV. (DENMARK). BOTANICAL INST.
Uptake and Photosynthetic Utilization of Sediment-Derived Carbon by Phragmites australis (Cav.) Trin. ex Steudel.
W91-05489 2H

AARHUS UNIV. (DENMARK). INST. OF ECOLOGY AND GENETICS.
Sulfur Cycle of Freshwater Sediments: Role of Thiosulfate.
W91-05583 2H

AARHUS UNIV. (DENMARK). ZOOPHYSIOLOGY LAB.
Effects of Cadmium on Anoxic Survival, Haematology, Erythrocytic Volume Regulation and Haemoglobin-Oxygen Affinity in the Marine Bivalve Scapharca inaequivalvis.
W91-05052 5C

Effects of Mercury on the Functional Properties of Haemoglobins from the Bivalve Mollusc Scapharca inaequivalvis.
W91-05053 5C

ABB ENVIRONMENTAL SERVICES, INC., WAKEFIELD, MA.
Developing a Risk Communication Strategy.
W91-05020 5F

ABO AKADEMI, TURKU (FINLAND). DEPT. OF ORGANIC CHEMISTRY.
Identification of Oxidized and Reduced Forms of the Strong Bacterial Mutagen (Z)-2-Chloro-3-(dichloromethyl)-4-oxobutenoic Acid (MX) in Extracts of Chlorine-Treated Water.
W91-05952 5F

ACER CONSULTANTS LTD., LONDON (ENGLAND).
Wastewater Reuse Case Studies in the Middle East.
W91-05543 3C

AFRC INST. OF GRASSLAND AND ANIMAL PRODUCTION, HURLEY (ENGLAND).
Odour and Ammonia Emissions Following the Spreading of Anaerobically-Digested Pig Slurry on Grassland.
W91-05847 5E

Model for Investment Appraisal of Grassland Drainage Schemes on Farms in the U.K.
W91-05923 4A

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, ATLANTA, GA. OFFICE OF HEALTH ASSESSMENT.
Health Effects Research Initiatives at the Agency for Toxic Substances and Disease Registry--Applicability to Contaminated Soils.
W91-05242 5E

AGRICULTURAL COLL. OF ATHENS (GREECE). LAB. OF SOILS AND AGRICULTURAL CHEMISTRY.
Hydraulic Conductivity and Leaching of an Organic Saline-Sodic Soil.
W91-05565 2G

AGRICULTURAL RESEARCH ORGANIZATION, BET-DAGAN (ISRAEL). INST. OF SOILS AND WATER.
Effect of pH on Permeability of Clay-Sand Mixture Containing Hydroxy Polymers.
W91-05182 2G

AGRICULTURAL RESEARCH ORGANIZATION, BET-DAGAN (ISRAEL). VOLCANI CENTER.
Estimation of Organic Chemical Sorption by Soils.
W91-05416 5B

Water-Drop Kinetic Effect on Water Infiltration in Calcium and Magnesium Soils.
W91-05598 2G

AGRICULTURAL RESEARCH SERVICE, BOISE, ID. NORTHWEST WATERSHED RESEARCH CENTER.
Aggregate Stability in the Palouse Region of Washington: Effect of Landscape Position.
W91-05187 2J

AGRICULTURAL RESEARCH SERVICE, COSHOCTON, OH.
Effect of Lumbricus terrestris L. Burrows on Hydrology of Continuous No-Till Corn Fields.
W91-05878 2G

AGRICULTURAL RESEARCH SERVICE, DAVIS, CA. AQUATIC WEED CONTROL RESEARCH LAB.
Influence of Temperature, Light and Nutrient Limitation on Anthocyanin Content of Potamogeton gramineus L.
W91-05487 2H

AGRICULTURAL RESEARCH SERVICE, DURANT, OK. WATER QUALITY AND WATERSHED RESEARCH LAB.
Siltation of Reservoirs in Agricultural Watersheds Determined Using Radioisotope Techniques.
W91-05658 2J

AGRICULTURAL RESEARCH SERVICE, FORT COLLINS, CO.
Analysis of Infiltration through a Two-Layer Soil Profile.
W91-05176 2G

AGRICULTURAL RESEARCH SERVICE, ORONO, ME. NEW ENGLAND PLANT, SOIL AND WATER LAB.
Soil Water Effects on the Use of Heat Units to Predict Crop Residue Carbon and Nitrogen Mineralization.
W91-05556 2G

AGRICULTURAL RESEARCH SERVICE, OXFORD, MS. SEDIMENTATION LAB.
Nutrient Trapping Efficiency of a Small Sediment Detention Reservoir.
W91-05926 2J

AGRICULTURAL RESEARCH SERVICE, PHOENIX, AZ. WATER CONSERVATION LAB.
Dynamic Response of Automatic Water-Level Controller: II. Application.
W91-05132 3F

Simple Derivation of the Retardation Equation and Application to Preferential Flow and Macrodispersion.
W91-05819 2F

AGRICULTURAL RESEARCH SERVICE, PHOENIZ, AZ. WESTERN COTTON RESEARCH LAB.
Ground Water Recharge with Sewage Effluent.
W91-05538 3C

AGRICULTURAL RESEARCH SERVICE, STONEVILLE, MS. SOUTHERN WEED SCIENCE LAB.
Efficiency of Methanol:Water Solutions for Metribuzin Extraction from Selected Soils.
W91-05563 5A

AGRICULTURAL RESEARCH SERVICE, UNIVERSITY PARK, PA. NORTHEAST WATERSHED RESEARCH CENTER.
Estimation of the Groundwater Pollution Potential on an Agricultural Watershed.
W91-05931 5B

AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS).
Approximative Techniques in the Operational Optimization of the Mahaweli Reservoir System in Sri Lanka.
W91-05628 4A

Real Time Operation of a Multipurpose Reservoir During Typhoon Occurrence.
W91-05629 4A

AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS). DEPT. OF HYDRAULICS AND CATCHMENT HYDROLOGY.
Water and Solute Movement in a Coarse-Textured Water-Repellent Field Soil.
W91-05448 2G

AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS). DEPT. OF NEMATOLOGY.
Potential of Basing an Ecological Typology of Aquatic Sediments on the Nematode Fauna: An Example from the River Rhine.
W91-04960 5A

AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS). DEPT. OF SOIL SCIENCE AND GEOLOGY.
Using Morphometric Expressions for Macropores to Improve Soil Physical Analyses of Field Soils.
W91-05873 2G

AGRICULTURE CANADA, BRANDON (MANITOBA). RESEARCH STATION.
Economics of Soil Erosion and Conservation on Six Soil Groupings in Manitoba.
W91-05938 2J

AGRICULTURE CANADA, OTTAWA (ONTARIO). LAND RESOURCE RESEARCH CENTRE.
Ponded Infiltration from a Single Ring: I. Analysis of Steady Flow.
W91-05177 2G

AHMADU BELLO UNIV., ZARIA (NIGERIA). DEPT. OF SOIL SCIENCE.
Crop Coefficients of Some Major Crops of the Nigerian Semi-Arid Tropics.
W91-05927 3F

AIX-MARSEILLE-2 UNIV., AIX-EN-PROVENCE (FRANCE). INST. DE GEOGRAPHIE.
Space-Time Variability of Rainfall in April and October-November over East Africa during the Period 1932-1983.
W91-05370 2B

AKADEMIA TECHNICZNO-ROLNICZA, BYDGOSZCZ (POLAND).
Cadmium Adsorption by Sewage Sludge-Treated Soil after Different Wetting and Dry Cycles.
W91-05479 5E

AKADEMIYA NAUK SSSR, MOSCOW. INST. GEOGRAFII.

AKADEMIYA NAUK SSSR, MOSCOW. INST. GEOGRAFII.
Nature of Permeability in Fine-Textured Soils.
W91-05219 2G

AKADEMIYA NAUK SSSR, MOSCOW. INST. OF SOIL SCIENCE AND PHOTOSYNTHESIS.
Modeling of Mass-Exchange of Phases in a Solonetzic Soil Leached after Application of Gypsum.
W91-05354 2G

AKADEMIYA NAUK SSSR, MOSCOW. POCHVENNYI INST.
Ortsteins in Sod-Calcareous Leached and Sod-Gley Calcareous Soils on Permian Clay Eluvium.
W91-05230 2K

AL-NAJAH NATIONAL UNIV., NABLUS (JORDAN). DEPT. OF CHEMISTRY.
Effect of Competition on the Adsorption of Some Ions (Copper, Zinc, Zirconium, Selenium, and Strontium) on River-Mud.
W91-05464 5B

ALASKA STATE DEPT. OF ENVIRONMENTAL CONSERVATION, JUNEAU.
Alaska's Response to the Exxon Valdez Oil Spill.
W91-05946 5G

ALASKA UNIV., FAIRBANKS. DEPT. OF MINING AND GEOLOGICAL ENGINEERING.
Modeling Solute Transport in Ground Water at or near Freezing.
W91-05816 5B

ALBERTA UNIV., EDMONTON. DEPT. OF CIVIL ENGINEERING.
Methods for Determining Assimilable Organic Carbon and Some Factors Affecting the Van Der Kooij Method.
W91-05058 5F

ALBERTA UNIV., EDMONTON. DEPT. OF GEOLOGY.
Chemical and Stable Isotopic Characteristics of Ground Water on Grand Cayman.
W91-05653 2F

ALL-UNION SCIENTIFIC RESEARCH INST. OF FODDER, FRUNZE (USSR). AGROMETEOROLOGICAL STATION.
Effect of the Meliorative State of Irrigated Lands of the Chu River Valley on the Water-Salt Regime and Yield.
W91-05826 3F

ALLIED-SIGNAL, INC., WARREN, NJ. AQUATECH SYSTEMS.
Aquatech Systems: A Technology for Metal Waste Recovery.
W91-05683 5D

AMBRIC, CAIRO (EGYPT).
Greater Cairo Wastewater Project.
W91-05804 5D

AMERICAN PETROLEUM INST., WASHINGTON, DC.
Current Issues in Management of Motor Fuel Contaminated Soils.
W91-05240 5G

AMERICAN WATER WORKS ASSOCIATION RESEARCH FOUNDATION, DENVER, CO.
Contaminants in Polyelectrolytes Used in Water Treatment.
W91-05024 5F

AMERICAN WATER WORKS SERVICE CO., INC., BELLEVILLE, IL. BELLEVILLE LAB.
Coliform Regrowth in Drinking Water: A Review.
W91-05023 5F

AMETEK, INC., SHEBOYGAN, WI.
New Developments in Point-of-Use/Point-of-Entry Drinking Water Treatment.
W91-05719 5F

AMSTERDAM UNIV. (NETHERLANDS). LANDSCAPE AND ENVIRONMENTAL RESEARCH GROUP.
Ecohydrological Parameters Indicating Different Types of Shallow Groundwater.
W91-05449 2F

AMWAY CORP., ADA, MI. RESEARCH AND DEVELOPMENT DIV.
Performance and Applications of Granular Activated Carbon Point-of-Use Systems.
W91-05706 5F

ANDHRA UNIV., WALTAIR (INDIA). DEPT. OF ZOOLOGY.
Toxicity of Mercury to the Freshwater Male and Female Field Crabs, Paratelphusa hydrodromous (Herbst) (Decapoda: Brachyura).
W91-05013 5C

ANTENNE DU CENTRE D'OCEANOLOGIE DE MARSEILLE, BP330, F-83507 LA SEYNE, FRANCE.
Gulf of Lions' Hydrodynamics.
W91-05452 2L

APPLIED SCIENCE AND ENGINEERING, INC., DAVIS, CA.
'Where's the Benzene': Examining California Ground-Water Quality Surveys.
W91-05818 5B

AQUA-ENVIRO, WAKEFIELD (ENGLAND).
Revival of Incineration in the UK.
W91-05507 5D

AQUATEAM-NORWEGIAN WATER TECHNOLOGY CENTRE OF OSLO (NORWAY).
Pretreatment of Yeast Industry Wastewater in an Aerated Balancing Tank and Its Effect on the Municipal Treatment Plant Performance.
W91-05518 5D

ARI TECHNOLOGIES, PALATINE, IL.
Groundwater Remediation Plan.
W91-05033 5G

ARIZONA DEPT. OF ENVIRONMENTAL QUALITY, PHOENIX. HYDROLOGY SECTION.
Underground Storage Tank Releases in Arizona: Causes, Extent, and Remediation.
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Holocene Vegetation of the Hornaday Mountains of Northwestern Sonora, Mexico.
W91-05597 2B

ARIZONA STATE UNIV., TEMPE. DEPT. OF CIVIL ENGINEERING.
Settlement and Moisture Movement in Collapsible Soils.
W91-05127 8D

ARIZONA STATE UNIV., TEMPE. DEPT. OF MECHANICAL AND AEROSPACE ENGINEERING.
Interfacial Mixing Caused by Turbulent Buoyant Jets.
W91-05419 8B

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Molecular Size Distributions of Dissolved Organic Matter.
W91-05320 5D

Parameter Estimation for Water Distribution Networks.
W91-05794 5F

ARIZONA UNIV., TUCSON. DEPT. OF CIVIL ENGINEERING AND ENGINEERING MECHANICS.
Application of the Boundary Element Method to Some Problems in Water Resources.
W91-05645 2F

ARIZONA UNIV., TUCSON. DEPT. OF HYDROLOGY AND WATER RESOURCES.
Ionic Tracer Movement through a Wyoming Snowpack.
W91-05490 5B

Laboratory Analysis of Fluid Flow and Solute Transport Through a Fracture Embedded in Porous Tuff.
W91-05836 2F

Steady Fluid Flow and Travel Times in Partially Saturated Fractures Using a Discrete Air-Water Interface.
W91-05837 2F

ARIZONA UNIV., TUCSON. DEPT. OF SOIL AND WATER SCIENCE.
Assessment of Vegetation and Soil Water Regimes in Partial Canopies with Optical Remotely Sensed Data.
W91-05032 2G

Generalized Results from Crop Yield Model with Saline Waters.
W91-05601 3C

ARIZONA UNIV., TUCSON. ENVIRONMENTAL RADIOISOTOPE CENTER.
Production and Transport of Carbon Dioxide in a Contaminated Vadose Zone: A Stable and Radioactive Carbon Isotope Study.
W91-05072 5B

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Guide Standards and Protocol for Testing Microbiological Water Purifiers.
W91-05705 5F

ARMY ENGINEER DISTRICT, JACKSONVILLE, FL.
Reservoir Filling Plans for Tropical Reservoirs--A Case Study.
W91-05630 4A

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MS.
User-Specific Water Demand Elasticities.
W91-05790 6D

Rapid Water Content by Computer-Controlled Microwave Drying.
W91-05871 8G

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MS. ENVIRONMENTAL LAB.
Comprehensive Analysis of Migration Pathways (CAMP): Contaminant Migration Pathways at Confined Dredged Material Disposal Facilities.
W91-05269 5B

Effects of Alum Treatment on Phosphorus Dynamics and Phytoplankton Response in Eau Galle Reservoir, Wisconsin.
W91-05271 5G

Guidelines for Vegetative Erosion Control on Wave-Impacted Coastal Dredged Material Sites.
W91-05275 4D

Guidance for Contracting Biological and Chemical Evaluations of Dredged Material.
W91-05276 5E

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MS. HYDRAULICS LAB.
Numerical Modeling of Hydrodynamics. Brazos Island Harbor Project, Texas (Brownsville Ship Channel).
W91-05268 2E

Red River Waterway, Revised Outlets for Red River Locks: Hydraulic Model Investigation.
W91-05272 2J

Abstracts of the Second International Symposium on Gas Transfer at Water Surfaces.
W91-05273 2A

ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MS. STRUCTURES LAB.
Preliminary Investigation of Cementitious Materials for Olmsted Lock and Dam.
W91-05270 8F

ARVIN/CALSPAN ADVANCED TECHNOLOGY CENTER, BUFFALO, NY.
Updating the Smith-Feddes Model.
W91-05277 2B

ASIAN INST. OF TECH., BANGKOK (THAILAND).
Nonlinear Chance Constrained Model for Irrigation Planning.
W91-05922 3F

ASIAN INST. OF TECH., BANGKOK (THAILAND). DIV. OF ENVIRONMENTAL ENGINEERING.
Application of Coarse-Media Slow Sand Filtration in Aquaculture.
W91-05509 5F

Sequencing Batch Anaerobic Reactors for Treatment of a High-Strength Organic Wastewater.
W91-05731 5D

Tannery Wastewater Treatment Using a Sequencing Batch Membrane Reactor.
W91-05773 5D

ATEC ASSOCIATES, INC., GRIFFITH, IN.
Hydrogeology and Tidal Analysis Along the Western North Coast of the Yucatan Peninsula, Mexico.
W91-05644 2F

ATMOSPHERIC ENVIRONMENT SERVICE, DOWNSVIEW (ONTARIO).
Precipitation Type Transition Regions in Winter Storms over Southern Ontario.
W91-05863 2B

ATOMIC ENERGY OF CANADA LTD., PINAWA (MANITOBA). WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT.
Characterizing In situ Stress Domains at the AECL Underground Research Laboratory.
W91-05362 8E

AUBURN UNIV., AL. DEPT. OF CHEMICAL ENGINEERING.
Demetallation and Recovery of Fuel Oil from Hazardous Waste Oil.
W91-05688 5E

BAHRAIN UNIV., MANAMA. DEPT. OF CHEMISTRY.
Chemical Analysis of Irrigation Waters in Bahrain.
W91-05545 3F

BANARAS HINDU UNIV., VARANASI (INDIA). CENTRE FOR ADVANCED STUDY IN BOTANY.
Employment of CEPEX Enclosures for Monitoring Toxicity of Hg and Zn on in Situ Structural and Functional Characteristics of Algal Communities of River Ganga in Varanasi, India.
W91-05108 5C

BANARAS HINDU UNIV., VARANASI (INDIA). INST. OF TECH.
Fly-Ash for the Treatment of Water Enriched in Lead(II).
W91-05463 5F

BANGLADESH AGRICULTURAL RESEARCH INST., JOYDEBPUR.
Water Use and Yield Relationships of Irrigated Potato.
W91-05928 3F

BANK OF AMERICA ENVIRONMENTAL SERVICES, ORANGE, CA.
Letting the Sleeping Dog Lie: A Case Study in the No-Action Remediation Alternative for Petroleum Contaminated Soils.
W91-05266 5G

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Artificial Ground-Water Recharge, Ventura County, California.
W91-05650 4B

BATTELLE, COLUMBUS, OH. ENVIRONMENTAL BIOLOGY AND ASSESSMENT.
Chronic Toxicities of Surfactants and Detergent Builders to Algae: A Review and Risk Assessment.
W91-05102 5C

BATTELLE MEMORIAL INST., COLUMBUS, OH.
Steady-State Analysis for Biological Treatment of Inhibitory Substrates.
W91-05318 5D

BATTELLE PACIFIC NORTHWEST LABS., RICHLAND, WA.
Wick Tensiometer to Measure Low Tensions in Coarse Soils.
W91-05188 2G

Recycling and Treatment of Metal-Bearing Spent Acids.
W91-05687 5E

BEIJING MUNICIPAL RESEARCH INST. OF ENVIRONMENTAL PROTECTION (CHINA).
Water Saving and Wastewater Reuse and Recycle in China.
W91-05542 5D

BELORUSSION SCIENTIFIC-RESEARCH INSTITUTE OF FORESTRY, USSR.
Nitrogen Losses from the Soil with Infiltrating Water in a Fertilized Pine Stand.
W91-05223 5B

BEN-GURION UNIV. OF THE NEGEV, SDE BOKER (ISRAEL). JACOB BLAUSTEIN INST. FOR DESERT RESEARCH.
Wastewater Disposal by Sub-Surface Trickle Irrigation.
W91-05544 3C

BENDER MACHINE, INC., VERNON, CA.
Substituting Thermal Spraying for Electroplating.
W91-05675 5G

BERN UNIV. (SWITZERLAND). GEOLOGICAL INST.
Fluorescence Spectroscopy of Aqueous Leaf Litter Extracts and Their Complexes with Aluminum.
W91-05181 2K

BOKSBURG TOWN COUNCIL (SOUTH AFRICA).
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W91-05290 5D

BOLOGNA UNIV. (ITALY). INST. OF AGRICULTURAL CHEMISTRY.
Interference of Soluble Silica in the Determination of Orthophosphate-Phosphorus.
W91-05407 5A

BOMBAY UNIV. (INDIA). DEPT. OF CHEMICAL TECHNOLOGY.
Effluent Treatment for Alcohol Distillery: Thermal Pretreatment with Energy Recovery.
W91-05912 5D

BORDEAUX-1 UNIV., TALENCE (FRANCE). LAB. D'ECOLOGIE FONDAMENTALE ET D'ECOTOXICOLOGIE.
Actions and Interactions of Temperature and Photoperiod on Mercury Accumulation by Elodea densa from Sediment Source.
W91-05103 5B

BOYCE THOMPSON INST. FOR PLANT RESEARCH, ITHACA, NY.
Effects of Ozone and Acidic Precipitation on the Growth and Photosynthesis of Red Spruce After Two Years of Exposure.
W91-04981 5C

BP EXPLORATION CO. LTD., LONDON (ENGLAND).
Ancient Subaerial Exposure and Freshwater Leaching in Sandstones.
W91-05368 2J

BREMEN UNIV. (GERMANY, F.R.). FACHBEREICH 2 - STUDIENGANG BIOLOGIE.
Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects.
W91-05107 5C

BRITISH COLUMBIA UNIV., VANCOUVER. DEPT. OF CIVIL ENGINEERING.
Development and Use of an Electrical Resistivity Cone for Groundwater Contamination Studies.
W91-05358 5A

Performance Data for a Sloped Reinforced Soil Wall.
W91-05365 8D

BRITISH COLUMBIA UNIV., VANCOUVER. DEPT. OF GEOLOGICAL SCIENCES.
Factors Controlling Debris Avalanche Initiation.
W91-05364 2J

BRITISH GEOLOGICAL SURVEY, WALLINGFORD (ENGLAND). HYDROGEOLOGY RESEARCH GROUP.
Method for Determining Volatile Organic Solvents in Chalk Pore Waters (Southern and Eastern England) and Its Relevance to the Evaluation of Groundwater Contamination.
W91-05417 5A

Problems of Ground-Water Development in Small Volcanic Islands in the Eastern Caribbean.
W91-05637 2F

Ground-Water Pollution Risk Assessment for Public Water Supply Sources in Barbados.
W91-05639 2F

BROOKHAVEN NATIONAL LAB., UPTON, NY. PROCESS SCIENCES DIV.
In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Epoxy Injection Repair of a Bridge Pier.
W91-05274 8G

BROX (GEORGE), INC., DRACUT, MA.
Hot Mix Asphalt Technology and the Cleaning of Contaminated Soil.
W91-05257 5G

BUREAU OF ENVIRONMENTAL PROTECTION, TAIPEI (TAIWAN).
Testing Stochastic Dynamic Programming Models Conditioned on Observed or Forecasted Inflows.
W91-05788 2E

BUREAU OF LAND MANAGEMENT, WASHINGTON, DC. WILDLIFE AND FISHERIES DIV.
Conservation Status of Threatened Fishes in Warner Basin, Oregon.
W91-05203 6G

C.A.A. BIOREMEDIATION SYSTEMS, BOSTON, MA.
Enhanced Bioremediation Techniques for In Situ and Onsite Treatment of Petroleum Contaminated Soils and Groundwater.
W91-05252 5G

CAIRO UNIV., GIZA (EGYPT). DEPT. OF ZOOLOGY.
Estimation of Fish Production and Potential Yield in Lake Manzala, Egypt.
W91-05001 2H

CALGON CORP., PITTSBURGH, PA.
Use of Carbon Adsorption Processes in Groundwater Treatment.
W91-05914 5G

CALIFORNIA DEPT. OF HEALTH SERVICES, BERKELEY. HAZARDOUS MATERIALS LAB. SECTION.
Anion-Exchange Chromatography Particle Beam Mass Spectrometry for the Characterization of Aromatic Sulfonic Acids as the Major Organic Pollutants in Leachates from Stringfellow, California.
W91-05073 5A

CALIFORNIA DEPT. OF HEALTH SERVICES, SACRAMENTO. ALTERNATIVE TECHNOLOGY SECTION.
Developing the Waste Reduction Assessment Manual (WRAM): An Aid to Waste Reduction.
W91-05671 5G

California Land Ban of Metal-Containing Aqueous Wastes.
W91-05672 5G

CALIFORNIA DEPT. OF HEALTH SERVICES, SACRAMENTO. TOXIC SUBSTANCES CONTROL DIV.
DHS Waste Reduction Program.
W91-05670 5G

CALIFORNIA STATE DEPT. OF WATER RESOURCES, SACRAMENTO.
Alternative Water-District Organization: Screening-Level Analysis.
W91-05792 6B

CALIFORNIA STATE UNIV., SACRAMENTO. DEPT. OF CIVIL ENGINEERING.
Measurement of Operator Training Benefits.
W91-05508 5G

CALIFORNIA UNIV., BERKELEY. DEPT. OF CIVIL ENGINEERING.
Stoichiometry and Kinetics of the Reaction of Nitrite with Free Chlorine in Aqueous Solutions.
W91-04950 5D

CALIFORNIA UNIV., BERKELEY. DEPT. OF ENTOMOLOGICAL SCIENCES.
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W91-05202 2H

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Phosphorus Behavior in Flooded-Drained Soils: I. Effects on Phosphorus Sorption.
W91-05602 2G

Phosphorus Behavior in Flooded-Drained Soils. II. Iron Transformation and Phosphorus Sorption.
W91-05603 2G

Phosphorus Behavior in Flooded-Drained Soils: III. Phosphorus Description and Availability.
W91-05604 2G

CALIFORNIA UNIV., DAVIS. DEPT. OF CIVIL ENGINEERING.
Role of Wastewater Reclamation and Reuse in the USA.
W91-05533 5D

CALIFORNIA UNIV., DAVIS. DEPT. OF GEOLOGY.
Light Stable Isotope Systematics of Large-Scale Hydrologic Regimes in California and Nevada.
W91-05838 2A

CALIFORNIA UNIV., LOS ANGELES. DEPT. OF CIVIL ENGINEERING.
Optimal Configuration and Scheduling of Ground-Water Tracer Test.
W91-05789 5B

CALIFORNIA UNIV., RICHMOND. RICHMOND FIELD STATION.
Copper Mine Drainage Treatment Plant Driven by Water Wheel.
W91-05693 5G

CALIFORNIA UNIV., RIVERSIDE. DEPT. OF SOIL AND ENVIRONMENTAL SCIENCES.
Production and Stability of Ethylene in Soil.
W91-05337 2G

Elevated Nitrate Levels in Soils of the Eastern Mojave Desert.
W91-05395 2K

Effect of Deicing Salts on Trace Metal Mobility in Roadside Soils.
W91-05408 4C

CALIFORNIA UNIV., SAN DIEGO, LA JOLLA. INST. FOR NONLINEAR SCIENCE.
Stability of Free Surface Sediment Flow.
W91-05170 2J

CALIFORNIA UNIV., SANTA BARBARA. DEPT. OF ECONOMICS.
Effects of Pricing Policies on Water Conservation and Drainage.
W91-05484 6C

CALIFORNIA UNIV., SANTA CRUZ. INST. OF MARINE SCIENCES.
PCB and PCT Contamination in Winter Quarters Bay, Antarctica.
W91-05345 5B

Copper Toxicity to Microscopic Stages of Giant Kelp Macrocystis pyrifera: Interpopulation Comparisons and Temporal Variability.
W91-05592 5C

CAMP, DRESSER AND MCKEE, INC., ATLANTA, GA.
Ground-Water Supply Study for the Nigua River Basin in the Dominican Republic.
W91-05638 2F

CAMP, DRESSER AND MCKEE, INC., CAMBRIDGE, MA.
Historic Town Recycles History for Wastewater Treatment.
W91-05027 5D

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W91-05173 2L

CAPE TOWN UNIV. (SOUTH AFRICA). DEPT. OF CHEMICAL ENGINEERING.
Configuration of Computer Based Control Systems for Wastewater Treatment Plants.
W91-05288 5D

D.O. Control: Extent of Problem in South Africa.
W91-05294 5D

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Extending the Capability of the Component Interaction Matrix as a Technique for Addressing Secondary Impacts in Environmental Assessment.
W91-04965 6G

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Solubilization of Polycyclic Aromatic Hydrocarbons in Micellar Nonionic Surfactant Solutions.
W91-05954 5G

CARTWRIGHT CONSULTING CO., MINNEAPOLIS, MN.
Membrane Separation Processes for Treatment of Hazardous Waste.
W91-05689 5D

CEA CENTRE D'ETUDES NUCLEAIRES DE CADARACHE, SAINT-PAUL-LES-DURANCE (FRANCE). INST. DE PROTECTION ET DE SURETE NUCLEAIRE.
Influence of Labelled Food Type on the Accumulation and Retention of 60-Co by a Freshwater Fish, Cyprinus carpio L.
W91-04979 5B

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Real Sample Analysis by ETA-LEAFS with Background Correction: Application to Gold Determination in River Water.
W91-05893 7B

CENTRAL MARINE FISHERIES RESEARCH INST., COCHIN (INDIA).
Physiological and Cellular Responses to Copper and Mercury in the Green Mussel Perna viridis (Linnaeus).
W91-05336 5C

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W91-05935 3F

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W91-05536 3C

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W91-05357 2D

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W91-05443 2F

CENTRO DE INVESTIGACION CIENTIFICA Y DE EDUCACION SUPERIOR DE ENSENADA (MEXICO).
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W91-05783 2L

CENTRO DE INVESTIGACION Y DESARROLLO, BARCELONA (SPAIN).
Estimated Inputs of Organochlorines from the River Ebro into the Northwestern Mediterranean.
W91-05344 5B

CERAMIC BONDING, INC., MOUNTAIN VIEW, CA.
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W91-05684 5E

CH2M HILL, DEERFIELD BEACH, FL.
Application of Ground-Water Artificial Recharge in a Brackish/Saltwater Environment.
W91-05649 2F

CH2M/HILL, DENVER, CO.
Potable Water Reuse.
W91-05809 5D

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Stormwater Management Utility Billing Rate Structure.
W91-05805 6C

CHEMFIX TECHNOLOGIES, INC., METAIRIE, LA.
Chemical Fixation of Heavy Metal-Contaminated Soils.
W91-05691 5G

CHEMSERVE TRIO (PTY) LTD., ISANDO (SOUTH AFRICA).
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W91-05297 5D

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W91-05933 5G

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W91-05594 2H

CLEMSON UNIV., SC. DEPT. OF CIVIL ENGINEERING.
Vapor-Budget Measurement of Irrigation Evaporative Losses.
W91-05135 3F

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Wave Forces on a Wall.
W91-05785 8B

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Toxicity Testing with Freshwater Algae in River Periyar (India).
W91-05015 5C

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Monitoring River Ice with Landsat Images.
W91-05031 2C

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Assessment of Porous Media Heterogeneity by Inverse Plume Analysis.
W91-05821 5B

New Tool: Delineation of Textural Heterogeneities in Unconfined Aquifers, Using Microgravity Surveys During Pumping.
W91-05937 2F

COLORADO STATE UNIV., FORT COLLINS.
Field Evaluation of Tissue Culture Derived Sorghum for Increased Tolerance to Acid Soils and Drought Stress.
W91-05558 2I

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Rating Correction for Lateral Settlement of Parshall Flumes.
W91-05133 7B

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W91-05657 4C

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W91-05802 5G

COMMISSARIAT A L'ENERGIE ATOMIQUE, LA SEYNE-SUR-MER (FRANCE).
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W91-05453 5B

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W91-05841 2G

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Sewage Clarification with Magnetite Particles.
W91-05780 5D

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Effect of Leaf Nitrogen and Water Regime on the Photosynthetic Capacity of Kenaf (Hibiscus cannabinus L.) under Field Conditions.
W91-05497 2I

Agronomic Studies on the Productivity of Kenaf (Hibiscus cannabinus L. cv. Guatemala 4) under Rainfed and Irrigated Conditions in the Northern Territory.
W91-05553 3F

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Root Growth and Water Uptake by Wheat during Drying of Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05493 2I

Alternative Methods of Estimating Water Deficit Stress of Wheat Grown on Undisturbed and Repacked Soil in Drainage Lysimeters.
W91-05494 2I

COMPANHIA PARANAENSE DE ENGERIA, CURITIBA (BRAZIL).
Design and Construction of the Segredo Concrete-Faced Rockfill Dam.
W91-05117 8A

COMPUTER ASSISTED DEVELOPMENT, INC., FORT COLLINS, CO.
Performance Measures for Evaluation of Irrigation-Water-Delivery Systems.
W91-05134 3F

CONNECTICUT UNIV., GROTON. MARINE SCIENCES INST.
Estimating Porosity of Partially Saturated Sediments.
W91-04940 2G

CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS, GERONA (SPAIN). CENTRO DE ESTUDIOS AVANZADOS DE BLANES.
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W91-05455 2H

CONSIGLIO NAZIONALE DELLE RICERCHE, PISA (ITALY). IST. PER LA CHIMICA DEL TERRENO.
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W91-05480 2G

Effect of Polyvinyl Alcohol, Dextran and Humic Acid on Some Physical Properties of a Clay and Loam Soil: II. Hydraulic Conductivity and Porosity.
W91-05481 2G

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W91-04953 5G

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W91-05169 8I

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W91-05116 8A

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Microbial Transformation of 1,2-Dibromo-3-Chloropropane (DBCP).
W91-05403 5G

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Pilot Plant Studies on Biological Sulphate Removal from Industrial Effluent.
W91-05736 5D

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Substrate Inhibition of Phenol Oxidation by a Strain of Candida tropicalis.
W91-05100 5D

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Cross-Flow Filtration of Colloids from Aquatic Environments.
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Predictions of Diurnal Fluctuations in an Algal Bacterial Clay Wastewater Treatment System.
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W91-05178 2K

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Flow Monitoring System for the Vaal and Wilge Rivers.
W91-05282 7B

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W91-05707 5F

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W91-05361 8D

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Rapid Ion-Exchange Technique for the Separation and Preconcentration of Chromium(VI) and Chromium(III) in Fresh Waters.
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Significance of Spatial Distribution of Microbial Species in Mixed Culture Biofilms.
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Conductivity as a Means of Control on the Demineralisation Plant at Matimba Power Station.
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W91-05695 5F

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W91-05947 5C

FEDERAL TRADE COMMISSION, WASHINGTON, DC.
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W91-05701 5F

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W91-04988 2H

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W91-05151 6E

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W91-04986 2H

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W91-05554 3F

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W91-05676 5G

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W91-05050 2K

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W91-05956 5A

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W91-05646 2F

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W91-05651 7B

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W91-05652 2F

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W91-05189 2G

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W91-05162 2I

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W91-05163 2G

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W91-05560 5A

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W91-05849 4D

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W91-05012 5B

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W91-05323 8B

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W91-05830 5C

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W91-05796 2B

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Biological Removal of Iron from Groundwater.
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W91-05130 2E

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W91-05746 5D

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W91-05887 2G

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W91-05777 5D

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W91-05606 2J

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W91-05476 3F

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Colombian Experience with Concrete Face Rockfill Dams.
W91-05119 8A

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W91-05059 5F

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W91-04943 5D

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W91-05767 5D

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W91-05635 2E

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W91-05660 5B

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W91-05890 2G

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W91-05526 5E

Estimation of Energy Saving for Melting Process on Sewage Sludge.
W91-05529 5E

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W91-05530 5E

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W91-05753 5D

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W91-05062 5C

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W91-05292 5D

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W91-05872 4C

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W91-05206 5D

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W91-05026 5D

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W91-05030 5D

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W91-05355 5B

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W91-05700 5F

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W91-05620 2B

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W91-05599 2G

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W91-05503 5D

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W91-05531 5E

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W91-05740 5D

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W91-04949 5E

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W91-05359 8D

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W91-05948 7C

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W91-05883 2F

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W91-05264 5G

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W91-05430 2D

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W91-05393 5D

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W91-05673 5G

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W91-05460 8I

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W91-05214 6E

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W91-04954 5B

MARMARA UNIV., ISTANBUL (TURKEY). DEPT. OF ENGINEERING.
Velocity and Depth of Flow Calculations in Partially Filled Pipes.
W91-05329 8B

MARYLAND UNIV. AT BALTIMORE. SCHOOL OF MEDICINE.
Non-O Group 1 Vibrio cholerae: A Look at the Epidemiology of an Occasional Pathogen.
W91-05037 5C

MARYLAND UNIV., CAMBRIDGE. HORN POINT ENVIRONMENTAL LABS.
Anticipated Effects of Climate Change on Estuarine and Coastal Fisheries.
W91-05165 2B

MARYLAND UNIV., COLLEGE PARK. DEPT. OF AGRICULTURAL ENGINEERING.
Ion Exchange Treatment of Subsurface Drainage Water.
W91-05924 5G

MARYLAND UNIV., COLLEGE PARK. DEPT. OF AGRONOMY.
Nutrient and Sediment Losses from Turfgrass.
W91-05396 5B

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Interactions between Shewanella colwelliana, Oyster Larvae, and Hydrophobic Organophosphate Pesticides.
W91-05096 5C

MASSACHUSETTS DEPT. OF ENVIRONMENTAL QUALITY ENGINEERING, WOBURN. DIV. OF HAZARDOUS WASTE.
Onsite Analytical Screening of Gasoline Contaminated Media Using a Jar Headspace Procedure.
W91-05247 5A

MASSACHUSETTS INST. OF TECH., CAMBRIDGE. DEPT. OF CHEMICAL ENGINEERING.
Study of Adsorption--Desorption of Contaminants on Single Soil Particles Using the Electrodynamic Thermogravimetric Analyzer.
W91-05953 5G

MASSACHUSETTS INST. OF TECH., CAMBRIDGE. DEPT. OF CIVIL ENGINEERING.
Mobilization of Colloids in Groundwater Due to Infiltration of Water at a Coal Ash Disposal Site.
W91-05413 5C

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Identifying Sources of Groundwater Pollution Using Trace Element Signatures.
W91-05898 5B

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W91-05245 5A

MASSACHUSETTS UNIV., AMHERST. DEPT. OF CIVIL ENGINEERING.
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W91-04946 5F

Cutoff Walls to Contain Petroleum Contaminated Soils.
W91-05255 5E

Fate and Transport of Combined Residual Chlorine in Small Stream.
W91-05325 5B

Bioremediated Soil Venting of Light Hydrocarbons.
W91-05918 5G

MASSACHUSETTS UNIV., AMHERST. DIV. OF PUBLIC HEALTH.
Reducing Drinking Water Sodium Concentrations Did Not Influence Adolescent Blood Pressure.
W91-05461 5F

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State of Research and Regulatory Approach of State Agencies for Cleanup of Petroleum Contaminated Soils.
W91-05244 5G

Council for Health and Environmental Safety of Soils (CHESS): A Coalition to Standardize Approaches to Soil Contamination Problems.
W91-05267 5G

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Polycyclic Aromatic Hydrocarbon Metabolism in the Polychaete Nereis virens.
W91-04993 5B

MASSACHUSETTS WATER RESOURCES AUTHORITY, BOSTON.
Selection of Egg-Shaped Sludge Digesters for Boston.
W91-05801 5D

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Use of Chloramines - Past, Present and Future.
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Fractals, Raindrops and Resolution Dependence of Rain Measurements.
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W91-05123 5E

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Concentrations of Synthetic Organic Chemicals in Leachate from a Municipal Landfill.
W91-05112 5B

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Differential Pressure Tiltmeter for Large-scale Ground Monitoring.
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Instrumentation for Rooiwal Watercare Works.
W91-05289 5D

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METCALF AND EDDY, INC., WAKEFIELD, MA.
Making Groundwater Safe to Drink.
W91-05034 5G

Use of a Remote Operated Vehicle (ROV) to Evaluate Marine Discharges of Treated Wastewater.
W91-05663 7B

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Sorption and Microbial Degradation of Naphthalene in Soil-Water Suspensions under Denitrification Conditions.
W91-05957 5B

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W91-04972 7B

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W91-05105 5G

MINNESOTA UNIV., MINNEAPOLIS. ST. ANTHONY FALLS HYDRAULIC LAB.
Convex Interpolation for Gradient Dynamic Programming.
W91-05834 7C

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W91-05609 2G

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MISSISSIPPI FOREST PRODUCTS UTILIZATION LAB., MISSISSIPPI STATE.
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W91-05144 5G

MISSISSIPPI STATE UNIV., MISSISSIPPI STATE.
Bioremediation Demonstration Unit at Weed, California.
W91-05145 5G

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W91-05092 5A

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W91-05442 2F

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W91-05626 2E

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W91-05215 2J

Microbial Populations of a Southern Chernozem as an Indicator of Irrigation Effects.
W91-05217 3F

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W91-05218 2G

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W91-05224 5B

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W91-05350 2G

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W91-05576 2G

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W91-05575 5B

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W91-05006 7B

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W91-05482 5B

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Critical Drought Analysis by Second-Order Markov Chain.
W91-05438 2E

TECHNICAL UNIV. OF LISBON (PORTUGAL). DEPT. OF CIVIL ENGINEERING.
Dissolved Oxygen in Small Wastewater Collection Systems.
W91-05512 5D

TECHNION - ISRAEL INST. OF TECH., HAIFA.
Speed of Two Moving Rainfall Events in Lund.
W91-05380 2B

TECHNION - ISRAEL INST. OF TECH., HAIFA. SHERMAN CENTER FOR RESEARCH IN ENVIRONMENTAL AND WATER RESOURCES ENGINEERING.
Effluents Quality Along a Multiple-Stage Wastewater Reclamation System for Agricultural Reuse.
W91-05540 3C

Should Waste Stabilization Ponds Be Designed for Perfect-Mixing or Plug-Flow.
W91-05757 5D

Performance of Stabilization Reservoirs as a Function of Design and Operation Parameters.
W91-05759 5D

TECHNISCHE HOCHSCHULE DARMSTADT (GERMANY, F.R.). INST. FUER WASSERVERSORGUNG, ABWASSERBESEITIGUNG UND RAUMPLANUNG.
Prediction of Oxygen Transfer Rates from Simple Measurements of Bubble Characteristics.
W91-05522 5D

TECHNISCHE UNIV. BRAUNSCHWEIG (GERMANY, F.R.). ABT. FUER PHYSISCHE GEOGRAPHIE UND LANDSCHAFTSOEKOLOGIE.
Evaluating Pesticide Migration in Tile-Drained Soils with a Transfer Function Model.
W91-05402 5B

TECHNISCHE UNIV. HAMBURG-HARBURG (GERMANY, F.R.).
Investigation on Wastewater Reuse on Passenger Aircraft.
W91-05550 5D

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Calcium Carbonate Precipitation in Anaerobic Waste Water Treatment.
W91-05730 5D

TEL-AVIV UNIV. (ISRAEL).
Increase of Early Rains in Southern Israel Following Land-Use Change.
W91-05409 2B

TENERA CORP., BERKELEY, CA.
Evaluation of Membrane Processes for the Reduction of Trace Organic Contaminants.
W91-05911 5D

TENNESSEE UNIV., KNOXVILLE.
Land Development and Water Quality: The Cayman Islands Study.
W91-05656 4C

TERRA VAC, INC., PRINCETON, NJ.
Cleanup of a Gasoline Contaminated Site Using Vacuum Extraction Technology.
W91-05259 5G

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Estimation of Area-Averaged Rainfall over Tropical Oceans from Microwave Radiometry: A Single Channel Approach.
W91-05855 2B

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Ability of Sorbent Materials to Adsorb and Retain Organic Liquids Under Landfill Conditions.
W91-05921 5B

TEXAS A AND M UNIV., COLLEGE STATION. GEOCHEMICAL AND ENVIRONMENTAL RESEARCH GROUP.
Recognition of Areas Effected by Petroleum Seepage: Northern Gulf of Mexico Continental Slope.
W91-05915 5B

Gulf of Mexico Hydrocarbon Seep Communities: VI. Patterns in Community Structure and Habitat.
W91-05917 5B

TEXAS AGRICULTURAL EXPERIMENT STATION, TEMPLE. BLACKLAND RESEARCH CENTER.
Cotton Root Growth and Soil Water Extraction.
W91-05610 2I

TEXAS SOUTHERN UNIV., HOUSTON. DEPT. OF CHEMISTRY.
Physical and Chemical Analysis of Egypt's Wadi El-Raiyan Man Made Lakes.
W91-05205 5B

TEXAS UNIV. AT AUSTIN. DEPT. OF CIVIL ENGINEERING.
Water Content-Density Criteria for Compacted Soil Liners.
W91-05379 5E

TEXAS UNIV. AT AUSTIN. DEPT. OF GEOLOGICAL SCIENCES.
Assessment of Future Coast Land Loss Along the Upper Texas Gulf Coast to the Year 2050.
W91-05936 2J

TEXAS UNIV. AT EL PASO. DEPT. OF CIVIL ENGINEERING.
Multi-Phase Partitioning of Trichloroethylene and Ortho-Xylene in Water Suspensions of Tuff: Experiments and Analysis.
W91-05920 5B

THESSALONIKI UNIV., SALONIKA (GREECE). INST. OF BOTANY.
Phytoplankton of a Warm Monomictic Lake--Lake Vegoritis, Greece.
W91-04998 2H

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Trends and Problems of Wastewater Reuse Systems in Buildings.
W91-05549 5D

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Ferrite Process; Heavy Metal Ions Treatment System.
W91-05517 5D

TOKYO SEWERAGE BUREAU (JAPAN). ENGINEERING RESEARCH AND DEVELOPMENT SECTION.
Sewage Sludge Utilization Technology in Tokyo.
W91-05501 5E

Technological Development of a Wastewater Reclamation Process for Recreational Reuse: An Approach to Advanced Wastewater Treatment Featuring Reverse Osmosis Membrane.
W91-05772 5D

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Development of a Microbial Community on Cellulose Buried in Waterlogged Soil.
W91-05555 2G

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Japan's Aqua Renaissance 90 Project.
W91-05766 5D

TOKYO UNIV. (JAPAN). DEPT. OF URBAN ENGINEERING.
Capability of On-Site Sewage Treatment System in Japan: Case Study in the Tokyo Suburb of Nagareyama City.
W91-05511 5D

Use of Reclaimed Wastewater for Ornamental and Recreational Purposes.
W91-05539 3C

Prevention of Lipid Inhibition in Anaerobic Processes by Introducing a Two-Phase System.
W91-05725 5D

Effect of Short-Term and Long-Term Changes in Hydraulic Conditions on Nitrifying Biofilm.
W91-05756 5D

TOKYO UNIV. (JAPAN). INST. OF INDUSTRIAL SCIENCE.
Application of Fiber Adsorbents in Water Treatment.
W91-05774 5D

TORONTO UNIV. (ONTARIO). DEPT. OF CHEMICAL ENGINEERING AND APPLIED CHEMISTRY.
Studies of Cadmium Uptake in Bone and Its Environmental Distribution.
W91-05895 5B

TORONTO UNIV. (ONTARIO). INST. FOR ENVIRONMENTAL STUDIES.
Anticipated Effects of Climate Change on Freshwater Fishes and Their Habitat.
W91-05164 2B

TOXIC RECOVERY SYSTEMS INTERNATIONAL, ELK GROVE, CA.
Case Study of a Minimum Discharge, Heavy Metal Waste Reduction System at Aeroscientific Corporation, Anaheim, California.
W91-05678 5D

TOYAMA PREFECTURAL PUBLIC WORKS DEPT. (JAPAN). SEWAGE DIV.
Operational Results of Melting System for Sewage Sludge.
W91-05504 5D

TOYOHASHI UNIV. OF TECHNOLOGY (JAPAN). DEPT. OF CIVIL ENGINEERING.
Effect of Roughened-Bed Stilling Basin on Length of Rectangular Hydraulic Jump.
W91-05424 8B

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Biological Treatment of Coke-Plant Wastewater for COD and NH3-N Removal.
W91-05516 5D

Comparison of One-Phase and Two-Phase Anaerobic Digestion Processes in Characteristics of Substrate Degradation and Bacterial Population Levels.
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Influence of Organic Matter from Soils and Sediments from Various Origins on the Sorption of Some Chlorinated Aliphatic Hydrocarbons: Implications on K(oc) Correlations.
W91-04948 5B

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New Method for Determining Concentrations of Endod-S (Phytolacca dodecandra) in Water During Molluscicide.
W91-05468 7B

TURIN UNIV. (ITALY). IST. DI MICROBIOLOGIA ED INDUSTRIE AGRARIE.
Anaerobic Digestion of Wastes Containing Pyr-olignitic Acids.
W91-05845 5D

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W91-05390 5C

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W91-05590 2H

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Relationship Between Moisture Capacity and Bulk Density of Podzolized Chernozem.
W91-05234 2G

UMGENI WATER BOARD, PIETERMARITZBURG (SOUTH AFRICA).
Control of the Pumped Water Supply to Wiggins Waterworks.
W91-05284 5F

UNDERGROUND WATER AUTHORITY, KINGSTON (JAMAICA).
Fate of Mevinphos Spill and Water Quality: A Case Study from Lakes Pen Municipal Dump.
W91-05659 5B

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Applications of Forward Modeling Resistivity Profiles.
W91-05814 2F

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International Programme For Environmentally Sound Hydrologic and Water Management Strategies in the Humid Tropics.
W91-05612 6A

UNIVERSIDAD COMPLUTENSE DE MADRID (SPAIN). DEPT. DE INGENIERIA QUIMICA.
Application of Gas Absorption Theories to o-Cresol Ozonation in Water.
W91-05056 5F

Effect of High Salt Concentrations on Ozone Decomposition in Water.
W91-05465 5F

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Regional Equations to Determine Peak Stream Discharges in the Santander Region, Colombia.
W91-05636 2E

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W91-05014 5B

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Use of Selected Autochthonous Soil Bacteria to Enhance Degradation of Hydrocarbons in Soil.
W91-05114 5G

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Experimental Study on Integrated Membrane Processes in the Treatment of Solutions Simulating Textile Effluents: Energy and Exergy Analysis.
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Anaerobic-Aerobic Treatment of Organic High-Strength Industrial Waste Water.
W91-05519 5D

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Determination of Heavy Metals and Radioactive Elements in Purifier Sludge.
W91-05209 5E

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W91-05800 5A

UNIVERSITY COLL., CARDIFF (WALES). SCHOOL OF PURE AND APPLIED BIOLOGY.
Episodic Pollution: Causes, Toxicological Effects and Ecological Significance.
W91-05039 5C

Venturi Aeration and Thermophilic Aerobic Sewage Sludge Digestion in Small-Scale Reactors.
W91-05094 5D

Microbial Populations and Sludge Characteristics in Thermophilic Aerobic Sewage Sludge Digestion.
W91-05095 5D

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Estimation of the GEV Distribution from Censored Samples by Method of Partial Probability Weighted Moments.
W91-05433 2E

Unbiased Estimation of Probability Weighted Moments and Partial Probability Weighted Moments from Systematic and Historical Flood Information and Their Application to Estimating the GEV Distribution.
W91-05434 2E

Nonparametric Variable Kernel Estimation with Historical Floods and Paleoflood Information.
W91-05839 2E

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W91-05005 5C

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Groundwater Contamination Studies--The State-of-the-Art.
W91-05848 5B

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Simulation Modeling of Primary Clarifiers (Case Study of Doha Treatment Plant).
W91-05207 5D

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Assessing Potential Health Risks from Viruses and Parasites in Reclaimed Water in Arizona and Florida, USA.
W91-05537 5D

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Geophysical Mapping and Hydrogeologic Analysis of Fresh-Water Lenses at Big Pine Key, Florida.
W91-05641 2F

Shape of Freshwater Lens in Small Carbonate Islands: Great Exuma Vs. Bermuda and the Effect of Climate.
W91-05643 2F

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Expectation of Maximum Daily Rainfall for the Central Climatic Region in Mississippi.
W91-05150 2B

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Oil Recovery and Waste Reduction by Microwave Radiation.
W91-05910 5D

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Historical Evidence for Southern Oscillation-Southern African Rainfall Relationships.
W91-05369 2B

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Formation, Colonization and Fate of Floating Sudds in the Maunachira River System of the Okavango Delta, Botswana.
W91-05485 2H

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W91-05067 2H

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W91-04990 2H

UPSTATE FRESHWATER INST., INC., SYRACUSE, NY.
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W91-04983 5B

URMIA UNIV. (IRAN). DEPT. OF IRRIGATION.
Force on Slab Beneath Hydraulic Jump.
W91-05423 8B

UTAH STATE UNIV., LOGAN. DEPT. OF AGRICULTURAL AND IRRIGATION ENGINEERING.
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W91-05929 3F

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W91-05106 5C

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Conditions for Successful Irrigation Projects in Africa.
W91-05618 3F

UTAH STATE UNIV., LOGAN. DEPT. OF NUTRITION AND FOOD SCIENCE.
Biological Treatment of Mercury Waste.
W91-05692 5D

UTAH STATE UNIV., LOGAN. DEPT. OF SOIL SCIENCE AND BIOMETEOROLOGY.
Evapotranspiration from the Margin and Moist Playa of a Closed Desert Valley.
W91-05428 2D

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Pilot-Scale Demonstration of Two-Phase Anaerobic Digestion of Activated Sludge.
W91-05724 5D

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W91-05807 5D

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W91-05940 5B

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Electrophiles and Acute Toxicity to Fish.
W91-05566 5C

Electrophiles and Acute Toxicity to Fish.
W91-05891 5C

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W91-05467 5C

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W91-05220 2G

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Pilot Plant Studies on Tannery Waste Water Treatment with the Objective to Reduce Sludge Production.
W91-05514 5D

VERSAR, INC., SPRINGFIELD, VA. UNDERGROUND STORAGE TANK BRANCH.
Application of Quantitative Risk Assessment Evaluation of Underground Storage Tanks to Insurance, Banking, and Real Estate Transactions.
W91-05261 6A

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Establishment and Production of Lucerne on a Salinised Clay Soil Irrigated with a Moderately Saline Groundwater.
W91-05552 3C

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W91-05049 5C

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Novel Chlorinated Terphenyls in Sediments and Shellfish of an Estuarine Environment.
W91-04952 5B

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W91-04942 5C

Effects of Increasing Acidity on Aquatic Protozoan Communities.
W91-04976 5C

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W91-04992 5C

Multiphase Flow and Transport in Porous Media.
W91-05798 5B

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Economic Decision-making Framework for Analyzing Atmospheric Deposition Impacts in Eastern U.S. Forests.
W91-05387 6B

VIRGINIA UNIV., CHARLOTTESVILLE. DEPT. OF ENVIRONMENTAL SCIENCES.
Development of an Automated Spatial Synoptic Climatological Classification.
W91-05373 2B

Influence of Mineralogy and Solution Chemistry on the Attachment of Bacteria to Representative Aquifer Materials.
W91-05414 5B

Use of Color Splitting and a Computer Technique to Separate Soil Moisture Groups.
W91-05605 2G

Inferences about Solute Transport in Macroporous Forest Soils from Time Series Models.
W91-05888 2G

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Catalase, Peroxidase and Superoxide Dismutase Activities in Seedlings Submitted to Increasing Water Deficit.
W91-05478 2I

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W91-05466 5B

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W91-05470 5B

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W91-05353 2G

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W91-04973 5B

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Geochemical Calculations and Observations on Salt Water Intrusions: II. Validation of a Geochemical Model with Laboratory Experiments.
W91-05440 2F

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W91-05231 2K

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W91-05352 2G

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W91-04989 2H

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W91-05919 5D

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W91-05793 6B

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W91-05192 3D

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W91-05806 5D

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W91-05065 4D

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POU/POE Product Promotion Guidelines and Code of Ethics.
W91-05702 5F

Water Quality Association Voluntary Product Validation Program and Voluntary Certification Program.
W91-05704 5F

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Recent Advances in Water Reuse Research in South Africa.
W91-05534 5D

WATER REUSE PROMOTION CENTRE, TOKYO (JAPAN).
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W91-05195 3A

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Recovery of Rinse Water and Plating Bath from Process Rinses Using Advanced Reverse Osmosis.
W91-05679 5D

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W91-05712 5F

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Dynamics and Control of Substrate Inhibition in Activated Sludge.
W91-04937 5D

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W91-05441 2G

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W91-05321 5B

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Simulation of Groundwater Flow in Complex Multiaquifer Systems: Performance of a Quasi Three-Dimensional Technique in the Steady-State Case.
W91-05360 2F

Ground-Water Contamination from Two Small Septic Systems on Sand Aquifers.
W91-05824 5B

Hydraulic Response of Highly Compressible Aquitards During Consolidation.
W91-05833 2F

Laplace Transform Galerkin Technique for Efficient Time-Continuous Solution of Solute Transport in Double-Porosity Media.
W91-05886 2G

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Effects of Liming on Nutrient Limitation of Epilithic Algae in an Acid Lake.
W91-04974 5G

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Myers Dump Case History: Innovative Utilization of Air Stripper-Activated Carbon Technologies.
W91-05913 5G

WESTON (ROY F.), INC., WALNUT CREEK, CA.
Field-Screening Techniques: Quick and Effective Tools for Optimizing Hazardous Waste Site Investigations.
W91-05246 5G

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W91-05250 5B

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W91-05486 5C

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W91-05699 5F

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W91-05386 6D

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Mass Flux Estimation and Mass Transport Mechanism in Estuaries.
W91-05582 2L

WISCONSIN UNIV., MADISON. DEPT. OF METEOROLOGY.
Retrieval of Precipitation Profiles from Airborne Radar and Passive Radiometer Measurements: Comparison with Dual-Frequency Radar Measurements.
W91-05852 2B

Diagnostics and Prediction of Anomalous River Discharge in Northern South America.
W91-05861 2E

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Preferential Flow in a Sandy Vadose Zone: 1. Field Observation.
W91-05876 2G

Preferential Flow in a Sandy Vadose Zone: 2. Mechanism and Implications.
W91-05877 2G

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W91-05823 2F

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W91-04945 5B

WOODS HOLE OCEANOGRAPHIC INSTITUTION, MA. DEPT. OF CHEMISTRY.
Investigation of Hydrogen Peroxide Chemistry in Surface Waters of Vineyard Sound with H2-18O2 and 18O2.
W91-05577 2K

WUHAN INST. OF HYDRAULIC AND ELECTRIC POWER ENGINEERING (CHINA).
Dynamic Response of Automatic Water-Level Controller: I. Theory.
W91-05131 3F

WYOMING UNIV., LARAMIE. DEPT. OF ECONOMICS.
Valuing Potential Groundwater Protection Benefits.
W91-05831 6B

YALE UNIV., NEW HAVEN, CT. DEPT. OF GEOLOGY AND GEOPHYSICS.
Metal Pollution in Sediments of Jamaica Bay, New York, USA-An Urban Estuary.
W91-05906 5B

YOKOHAMA CITY SEWAGE WORKS BUREAU (JAPAN). RESEARCH AND DEVELOPMENT DIV.
Operation of Centralized Sludge Treatment Facilities.
W91-05502 5D

ACCESSION NUMBER INDEX

W91-04937 5D
W91-04938 2B
W91-04939 2F
W91-04940 2G
W91-04941 5B
W91-04942 5C
W91-04943 5D
W91-04944 5D
W91-04945 5B
W91-04946 5F
W91-04947 5A
W91-04948 5B
W91-04949 5E
W91-04950 5D
W91-04951 5B
W91-04952 5B
W91-04953 5G
W91-04954 5B
W91-04955 5D
W91-04956 5A
W91-04957 5B
W91-04958 5B
W91-04959 5C
W91-04960 5A
W91-04961 5C
W91-04962 5C
W91-04963 5C
W91-04964 5C
W91-04965 6G
W91-04966 4C
W91-04967 5B
W91-04968 5B
W91-04969 5B
W91-04970 5B
W91-04971 5B
W91-04972 7B
W91-04973 5B
W91-04974 5G
W91-04975 5B
W91-04976 5C
W91-04977 2K
W91-04978 2K
W91-04979 5B
W91-04980 5B
W91-04981 5C
W91-04982 5B
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W91-04987 2H
W91-04988 2H
W91-04989 2H
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W91-04994 5C
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W91-04998 2H
W91-04999 2K
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W91-05007 5B
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W91-05461 5F
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W91-05467 5C
W91-05468 7B
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W91-05470 5B
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W91-05474 5E
W91-05475 3F
W91-05476 3F
W91-05477 2K
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W91-05486 5C
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W91-05499 5D
W91-05500 5D
W91-05501 5E
W91-05502 5D
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W91-05651 7B
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W91-05658 2J
W91-05659 5B
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W91-05663 7B
W91-05664 5D
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W91-05666 5A
W91-05667 5F
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W91-05715 5F
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W91-05717 5F
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W91-05719 5F
W91-05720 5D
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W91-05750 5D
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W91-05759 5D
W91-05760 5D
W91-05761 5D
W91-05762 5D
W91-05763 5D
W91-05764 5D
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W91-05771 5D
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W91-05800 5A
W91-05801 5D
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W91-05803 5F
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W91-05809 5D
W91-05810 6B
W91-05811 5D
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* U.S. G.P.O.:1991-281-553:20013

Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

6 WATER RESOURCES PLANNING

7 RESOURCES DATA

8 ENGINEERING WORKS

9 MANPOWER, GRANTS, AND FACILITIES

10 SCIENTIFIC AND TECHNICAL INFORMATION

INDEXES

SUBJECT INDEX

AUTHOR INDEX

ORGANIZATIONAL INDEX

ACCESSSION NUMBER INDEX

1991 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports

Standard Prices		*Exception Prices*	
A01	$8.00	E01	$10.00
A02	11.00	E02	12.00
A03	15.00	E03	14.00
A04–A05	17.00	E04	16.50
A06–A09	23.00	E05	18.50
A10–A13	31.00	E06	21.50
A14–A17	39.00	E07	24.00
A18–A21	45.00	E08	27.00
A22–A25	53.00	E09	29.50
A99	*	E10	32.50
		E11	35.00
"N" Codes		E12	38.50
		E13	41.00
N01	$60.00	E14	45.00
N02	59.00	E15	48.50
N03	20.00	E16	53.00
		E17	57.50
		E18	62.00
		E19	69.00
		E20	80.00
		E99	*

Computer Products

Diskettes		*Magnetic Tapes*	
D01	$50	T01	$165
D02	80	T02	220
D03	130	T03	340
D04	180	T04	450
D05	230	T05	560
D06	280	T06	670
D07	330	T07	780
D08	380	T08	890
D09	430	T09	1,000
D10	480	T10	1,110
D11	530	T11	1,220
D12	580	T12	1,330
D13	630	T13	1,440
D14	680	T14	1,550
D15	730	T15	1,660
D16	780	T16	1,770
D17	830	T17	1,880
D18	880	T18	1,990
D19	930	T19	2,100
D99	*	T99	*

* Contact NTIS for price

Prices effective January 1, 1991

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